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AN ECOLOGICAL STUDY OF THE ALGAE OF SOME SANDHILL LAKES

BY EMMA N. ANDERSEN AND ELDA R. WALKER

INTRODUCTION

Much of the western part of Nebraska consists of rolling sandhills covered with bunchgrasses, yuccas, cacti, and other dry-land plants. Cherry county which is situated in the north central part of the sandhills has in its valleys many bodies of water. In one area of 250 square miles there are about 75 lakes. This region is twenty-five miles southwest from the village of Woodlake and about the same distance south of Valentine. These lakes vary greatly in size. Some are ponds a few hundred feet in diameter while the largest of the group is about four and a half miles long and three-fourths of a mile wide. All are comparatively shallow bodies of water, varying in depth from a couple of feet to a maximum of fifteen feet. The accompanying map¹ (Fig. 1) shows the relative size and arrangement of the lakes of this region.

Surrounding the lakes are low meadows covered with grasses and prairie flowers.² These meadows extend back from the lakes anywhere from a rod to, in some cases, a mile or more. Surrounding the grasslands rise the "sandhills"—dunes of yellowish sand extending to the next lake with its surrounding grasslands (Fig. 2). The few native trees are stunted and produce no effect on the landscape.

The climate is that typical of the central plains, dry, windy, hot in summer, and cold in winter. In the summer of 1912, the average maximum daily temperature from June 24th to August 3rd was 91.2°, while the average minimum temperature was 59.8°. During the same period the wind velocity reached a maximum of 21.9 miles per hour, the average for a twelve hour period, while the lowest average for a similar period was 1.3 miles per hour.

¹ Furnished by Dr. G. E. Condra of the University of Nebraska.

² The vegetation of this region is well discussed by Pool (36).

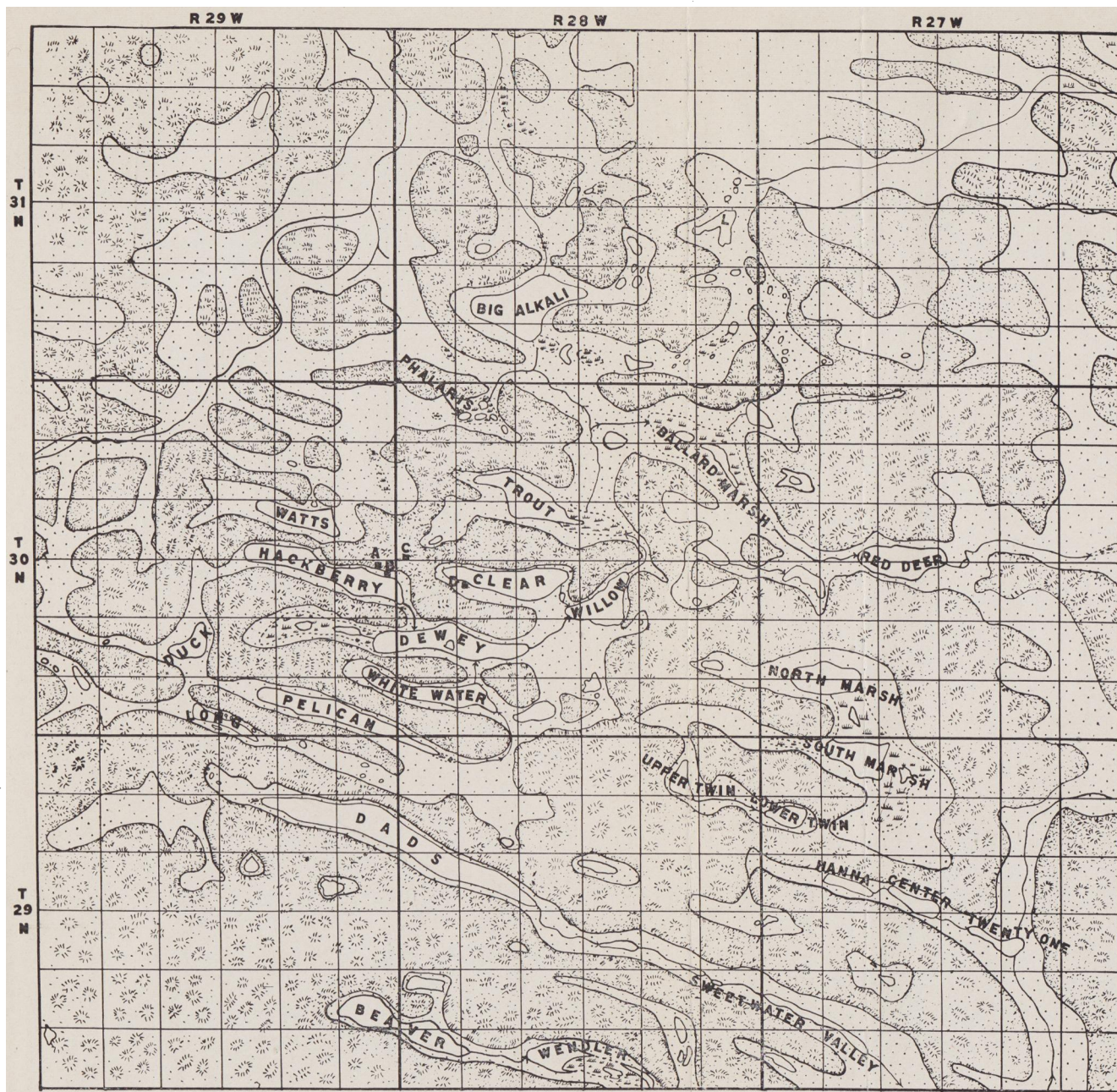


PLATE III

Fig. 1.

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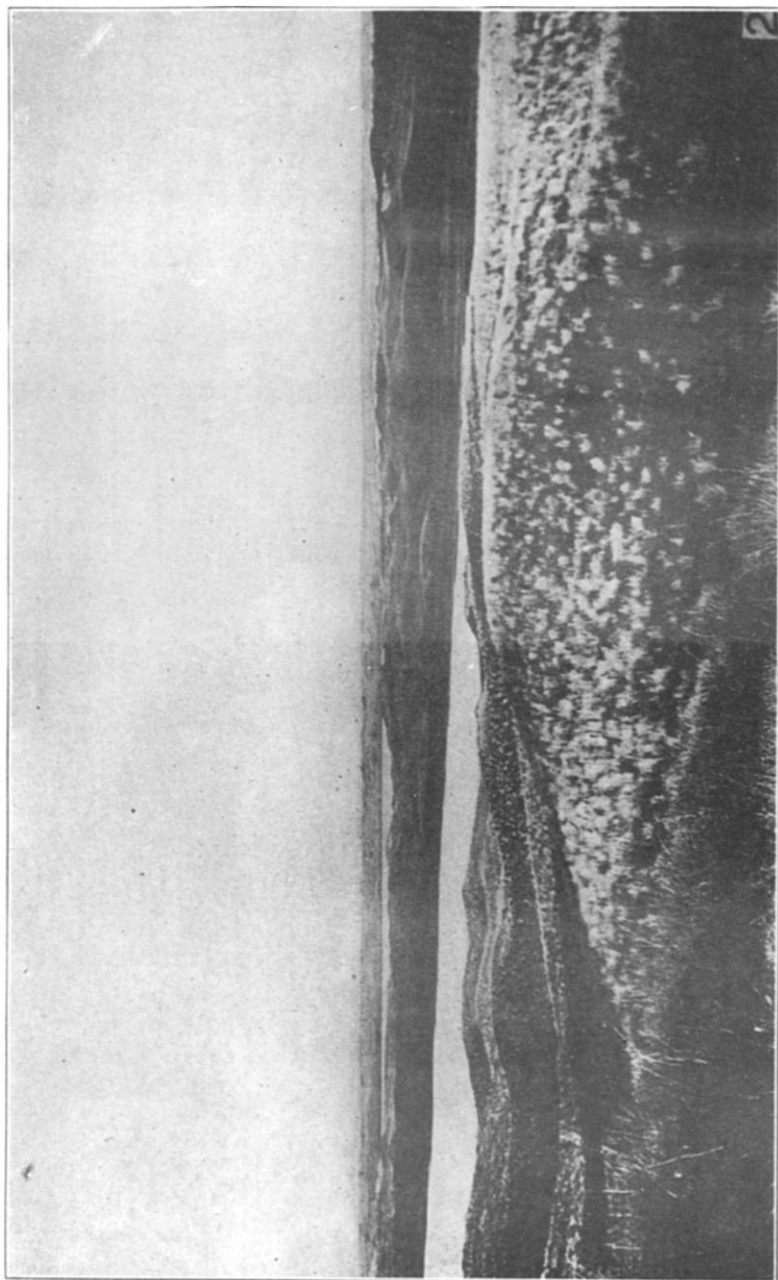


PLATE IV

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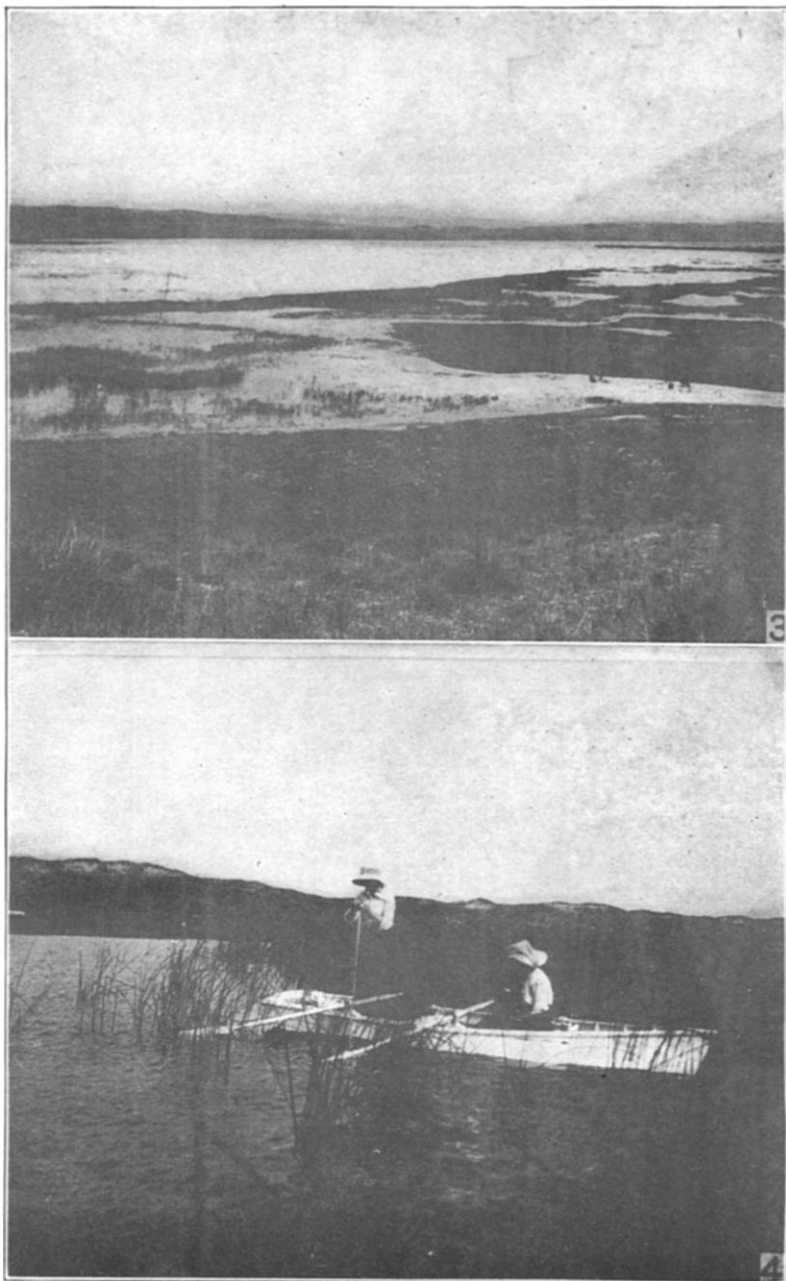


PLATE V

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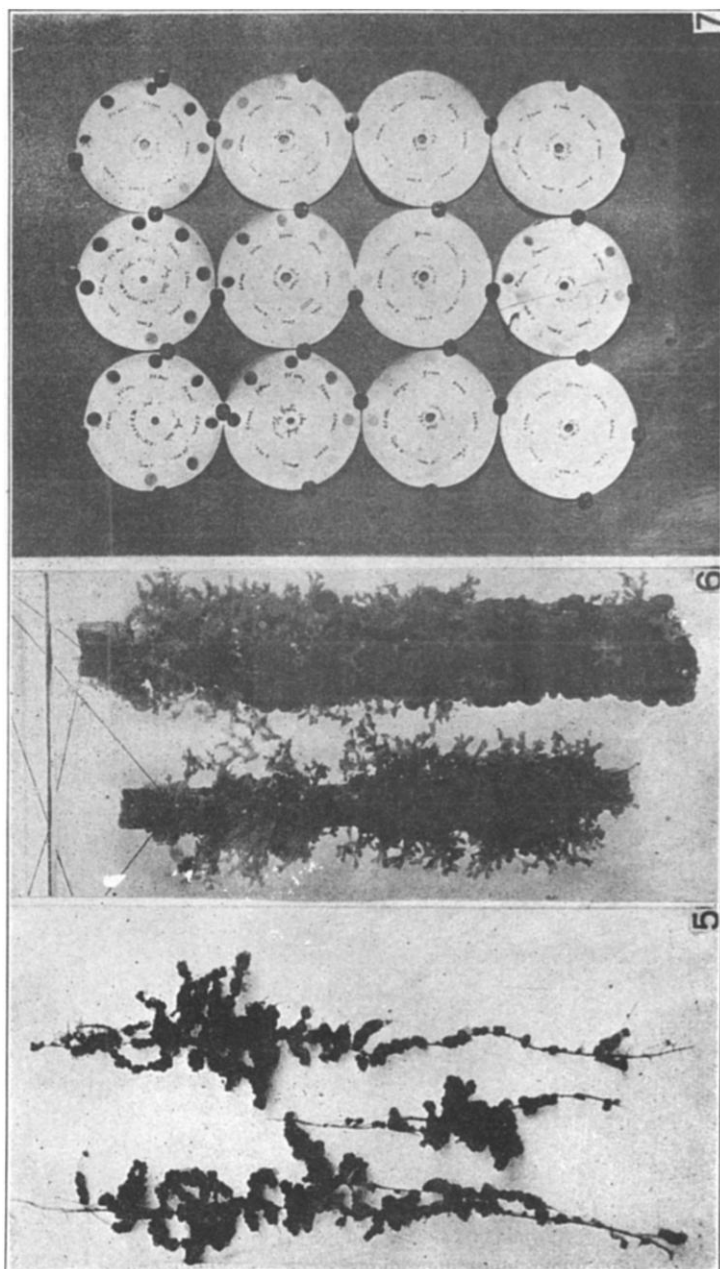


PLATE VI

ANDERSEN AND WALKER

The high daily temperature warms the water of the shallow lakes and the prevailing high winds stir it, frequently mixing the warm surface layers with those below causing thorough aëration. The climatic conditions together with the abundance of water plants, such as *Chara*, *Myriophyllum*, *Potamogeton*, *Scirpus*, *Nymphaea*, and *Zizania*, which give anchorage for attached forms, make an ideal habitat for algae.

Although complete analyses of the water of the lakes are not available, some idea of their alkalinity may be obtained from analyses made by the department of chemistry of the University of Nebraska of samples of water taken by Dr. R. H. Wolcott. These were made in 1911 and showed the following parts per million of alkali:

Watts Lake, 111

Dewey Lake, 160

Hackberry Lake (no analysis made)

Big Alkali Lake, 622

Clear Lake, 1,129

As the analyses show some of the lakes are adapted to the algae of fresher waters, while others are so alkaline that very few forms can inhabit them. There is evidence that all of the series of lakes belonged formerly to one general system. The larger lakes have well formed shore lines except at their northwest ends where many of them are swampy. This gives farther variations in the habitat for algae.

Surrounded by a large semiarid region, these lakes with their large beds of wild rice and other seed producing plants prove a most tempting resting and feeding place for migratory birds. They flock here in large numbers and, no doubt, bring on their mud-laden feet spores of algae from ponds both north and south—the only explanation for some of the species present.

Earlier students working with the higher plants of the sandhills reported a rich algal flora. This led the writers to spend the summer of 1912 in studying the algae of the region and the conditions under which they live. At first it was hoped to cover the entire group of lakes, but after a few preliminary trips through the region, the work was limited to a few localities so situated that they could be frequently visited. These were chosen to represent so far as possible the different types of habitat found in the region.

From the various localities, specimens were collected by hand either from a boat or by wading. A Birge net was also used to secure free floating forms.

The identifications of species are based upon Tilden's Myxophyceae, Collins' Green Algae of North America, and West's British Desmidiaceae. In groups such as the Oedogoniaceae, Characeae, and Helminthocladiaceae covered by special publications, the identifications were made with the works cited. Constant reference was made to the other systematic works listed at the end of this paper.

The nomenclature of DeToni is followed except for the Desmids where that of West is used. In the case of a few species not given in the above general works, the terminology of the author describing the form is used.

All diatoms were identified by Dr. C. J. Elmore. The one *Volvox* found was identified by Dr. J. H. Powers. Acknowledgments are also due Mr. F. H. Shoemaker for the photographs from which figures 2, 10, 11, and 12 were taken; to the Nebraska Conservation and Soil Survey for help in prosecuting the work; to Prof. B. E. Moore for suggestions as to physical problems; and to Prof. T. J. Fitzpatrick for careful reading of manuscript and proof.

HACKBERRY LAKE

Hackberry lake (Fig. 1, 3) was chosen for a study of water conditions, because it was representative and conveniently located. It is a lake two and a half miles long and one-half mile wide. In depth it varied during the summer of 1912 from three to seven feet. The maximum depth, however, was found only in a few places. Usually it did not exceed four feet.

The shore is sandy except at the northwest end where it is freshly formed by the filling in of decomposing vegetable matter. This end is swampy and passes gradually into dense beds of *Zizania*, *Scirpus*, *Myriophyllum*, *Potamogeton*, and similar water plants. Here the water is so filled with vegetation that it is almost impenetrable with a boat or otherwise.

The southeast half of the lake was more open. Dense beds of water plants were scattered through it but between them were areas of open water, (Fig. 4). Here the algae were most abundant. It was in this region that records of water conditions were made.

Algae were abundant all over the lake but more so in this part where every rush stem, every lily pad, in fact, every submerged plant was loaded with them (Figs. 5, 6). The number of species was not large, as the list which follows shows, but the number of individuals was very great. For example, a count was made of the thalli of *Chaetophora elegans*. On one old *Scirpus* stem there were 592 thalli. In an area one meter square, there were 103 stems loaded in a similar way, making over sixty thousand thalli of *Chaetophora elegans* in a square meter. *Chaetophora cornu-damae*, *Nostoc glomeratum*, *Gongrosira debaryana*, and *Rivularia natans* were equally abundant, while other species were only slightly less so.

CLIMATIC CONDITIONS

The accompanying graphs (Figs. 15, 16, 17) are intended to illustrate weather conditions surrounding the lake. The station, (C on Fig. 1) represented in Fig. 8, was in a blowout about $\frac{1}{4}$ mile from the lake. In the graph (Fig. 15) line A shows the daily variation in temperature of this station as recorded by a Fries self-registering thermograph. Line D shows the temperature on the north side of a small house, a few rods from the lake (A on Fig. 1) as registered by a maximum and minimum thermometer. Line C shows the temperature of the surface sand as recorded by a Fries self-registering soil thermograph whose bulb was barely covered with sand. B gives the temperature of the sand eight inches below the surface as recorded by a similar instrument. The wind record was made by a standard anemometer (Julien P. Fries), so only the averages of wind velocity for twelve hour periods are available, but it gives some estimate as to wind in the region. The high air temperature and its effect on the surface temperature of the light sand when compared with the temperature of the sand eight inches below the surface shows that comparatively little heat penetrates deeply into the soil—a fact that may have some bearing on the temperature of the water of the lakes in some instances. Fig. 16 is a similar record for a much cooler week taken in the grass of the meadow (Fig. 9) on the lake shore (B on Fig. 1).

WATER CONDITIONS

Temperature and Wind

For a month, July 8 to August 6, the same instruments were stationed in a boat on this lake to determine, so far as possible, the temperature conditions under which the algae were growing. During this time the anemometer was placed on a post about six feet above the surface of the water and a hundred feet from the water's edge to determine the velocity of the wind passing over the water. The thermographs in the boat recorded the temperature (*A*) of the air in the boat, the temperature (*C*) of the surface water, and the temperature (*B*) of the water at the bottom of the lake. Due to drifting of the boat to a slightly different position, the depth at which the temperature was taken varied from three feet the first week to four and one-half the second and fourth weeks and five feet the third week. The temperatures were not taken in deeper parts of the lake because there the algal growth was slight. As can be seen from the accompanying graph (Fig. 17) the temperatures of the surface and bottom water approach each other very closely except on days of low wind, when the temperature of the surface water varies considerably from that at the bottom. This effect of air temperature and wind was especially evident in the fourth week when great variations in air temperature occurred.

It will be noticed that during a large part of this month, the water temperatures were between 70° and 80° F., and that the temperature of the water at all levels was remarkably uniform. It is evident from the divergences of the temperature of surface and bottom water during each period of lower wind that the uniformity of the water temperature is due largely to stirring by wind. Also that a constant stirring would produce good aëration in all parts of the water is an inevitable conclusion.

Hackberry lake is one of the less alkaline of the lakes in this group. It is, however, more alkaline than some of its neighbors as was noted before.

Light

A modification of the common solio paper photometer (text Fig. 1) was devised to study the light conditions under which the algae were

growing.¹ This consisted of a water tight circular drum (A) at the end of a metal tube (D). Inside of this drum was a disk (G) which revolved by means of a rod (E) passing through the tube and connected with a lever at the top. This disk (G) carried the paper (F) on its under surface. It was perforated by eight holes (B) of the same size as a clear glass window (C) in the drum. By revolving the inner disk, the areas of solio paper under the perforation of the disk could be exposed to the light through the window (C). The tube and

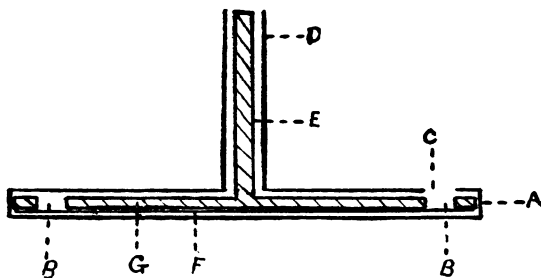


Fig. 1

rod inside of it were made in sections so they could be extended to the necessary length. The tube was marked in decimeters on the outside so the depth could be ascertained at all times. With this instrument, light readings were taken from a boat (Fig. 4) at various depths. Care was taken to have the window in the drum exposed to direct light at all times. In some instances, the period of exposure was uniform and the depth was varied; in other cases both depth and period of exposure were varied and in still others one depth was maintained during the series of readings and the period of exposure was varied.

Records taken by the last method are shown in (Fig. 7). The top row shows exposures made in the air beginning at the following hours, reading from left to right: 10:18 a.m., 10:30 a.m., and 2:10 p.m. In each record the exposures were 60, 45, 40, 30, 20, 10, 5, and 2 seconds.

Below are nine water records taken the same day and at intervals immediately following or preceding the air exposures. These are

¹ This instrument was made by the Spencer Lens Company.

arranged in order by depths, the first being one decimeter below the surface and each succeeding one a decimeter deeper, making the last nine decimeters deep. In all the periods of exposure were the same as the air records, except the last two. Here no records could be secured at the above exposure periods so the time was increased in record 8 to 2, 3, 4, 5, 6, 7, and 8 minutes and in record 9 to 1, 2, 3, 4, 5, 6, 7, and 8 minutes. All water readings were compared with exposures made in the air at the same hour. In no cases were the readings satisfactory but some facts of interest were recorded.

1. Waves on the surface water varied the record of light intensity greatly. On very windy days the intensity of light under the water was so variable that one exposure showed almost no coloration while the next at the same depth and period of exposure was deeply colored. The only explanation evident was that the change in angle of surface layer deflects the light almost entirely at times and not at other times. On account of this variability readings on windy days were early discontinued.

2. Before 9 A.M. or after 3 P.M. it was almost impossible to get a usable tint on the solio paper, although to the eye it was entirely light to the bottom of the lake. Evidently the angle between the sun's rays and the surface of the water was such that most of the rays were deflected and the water light was simply reflected light and not of a kind or quantity to affect solio paper.

3. Exposures made at a given depth but with different periods of exposure gave very different records as to relative light intensity. The shorter the exposure, the greater reduction of light, according to the readings. When the exposure required more than three minutes the error was so great that the reading was useless for comparison with readings of shorter periods. Two series will illustrate the point. The exposures were consecutive in both cases.

Time	Relative intensity All at 4 dm. deep	Time	Relative intensity All at 8 dm. deep
3 min.....	.111	4 min.....	.0083
2 min.....	.125	5 min.....	.0166
1 min.....	.083	6 min.....	.0277
½ min.....	.05	7 min.....	.0357
		8 min.....	.0416

Such a series can only be explained by the well known fact that the reduction of silver in a photographic paper is not a uniform process. Since these results proved a variable period impracticable, exposures were made for a given period at various depths. These readings showed clearly a constant reduction of light as the depth was increased and agreed in general with the results obtained by Needham and Lloyd (33), by Birge (11), and by Oltmanns (34).

4. Exposures made for constant periods at various depths showed the light to be reduced by passing through the water. However, this gave no accurate measure of the light at given depths, because such exposures were compared with air tints of various periods of exposure. These we have just shown to be unreliable because of the inconstant reduction of the photographic film.

5. Solio paper is sensitive only to the blue-violet end of the spectrum. It is generally conceded that it is the red-orange end of the spectrum that is most largely used by plants in photosynthesis (Dangeard 22). It is, therefore, evident that tests made with solio paper are of little value in determining the light conditions under which algae grow. Such tests show in a most general way, as noted above, that the direct rays of light are largely deflected except during the middle of the day and that the light is reduced by passing through water. Both facts are well known to physicists. This means that water plants have a shorter day than air plants and that they grow in less intense light at all times. In other words, as Oltmanns (34) states, they are all shade plants.

6. Light readings taken in October show less light penetrating the water than was found in July and August. The following table shows this as well as could be determined from solio paper records. Because of the reasons already given these records can only be regarded as a crude estimate. The figures given are compiled from a large number of readings so that the general diminution of blue light per decimeter of depth and the relative intensity between the light of midsummer and that of October are approximately correct.

Dm.	August	October
1	.5	.2
2	.25	.1
3	.173	.066

Dm.	August	October
4	.083	.05
5	.05	.033
6	.033	.016

No doubt the reduction of light in October is due to the rays of the sun striking the water more obliquely. Hence water plants have not only a shorter day but also a shorter growing season than land plants.

It is evident that the main advantage in the present attempt to measure light with reference to that used by plants under water is to prove the absolute uselessness of the solio paper method.

Later the same photometer was modified slightly so that plates sensitive to all kinds of light could be used in it (Figs. 10, 11, 12). A color screen was added and in that way an attempt was made to measure the red-orange light penetrating the water. Fig. 10 shows the upper side of the drum which holds the photographic plate and the detachable color screen over the exposure window. This is shown again in Fig. 12 (below) with the tube removed. At the top of Fig. 12 is shown the under side of the upper half of the drum. The inner disk shows two clips for holding the plate in place and eight perforations through which areas of the plate may be exposed to the light of the window. This disk is revolved, exposing alternately a perforation and a solid area, by a rod passing through the tube and connected with the lever at the top (Fig. 11). This apparatus for making exposures, while entirely rapid enough for solio paper, proved altogether too slow for the highly sensitive plates. The only results obtained indicated that red light penetrating many decimeters of water was too strong for more than instantaneous exposures on these plates. It is believed that a similar apparatus fitted with a shutter that would make possible exposures of a fraction of a second would come much nearer to giving an estimate of light available for the use of algae. Even here the reduction of the photographic film would not be uniform and some error would remain. Öltmanns (34) states that physicists have shown that the light from each part of the spectrum is deflected and absorbed differently by pure water. The water inhabited by algae is always modified in color and transparency both by its chemical content and by the presence of floating organisms giving turbidity to the water. An instrument such as the above would give an idea as to what effect such water conditions have upon

the quality of light used by algae even tho it did not give accurate information as to the quantity of light available for them.

Murray and Hjort (32) investigating light conditions in the ocean, by means of the Helland-Hansen Photometer and pan-chromatic photographic plates found that red light penetrated the water less than did blue and indigo. This agrees with the results cited by Oltmanns (34) for pure water. This suggests, in some cases at least, that actual light available for submerged plants is far below the amount indicated by the solio paper photometer.

DISTRIBUTION

As is readily seen from the physical factors noted above, this lake is characterized by fairly uniform temperature, aëration, and alkalinity. There remain but two factors that can influence the distribution of algae in this lake—light and mechanical support. The distribution may be entirely explained by these factors.

Attached forms as *Rivularia pisum*, *Nostoc glomeratum*, etc., grow at a depth of about 3–4 dm. below the surface of the water. When they are near the margin of the lake they grow on small submerged sedges, chara, etc. In deeper water they grow on Potamogeton, Myriophyllum, and such taller plants, but at remarkably uniform distances below the surface. On the other hand, *Nostoc pruniforme*, lying free at the bottom of the lake, was only found near the margin where the water was two or at most three decimeters deep. At first such forms led to the opinion that there was a zonal arrangement about the shore such as is suggested by Comère (17) but the theory did not stand the test. The distribution was entirely a vertical one caused undoubtedly by the light intensity. There were several conspicuous examples which demonstrate this. *Chaetophora elegans* extended on Scirpus stems, almost its only support, over a distance of two decimeters but the growth was constantly most abundant in the upper region, within $\frac{1}{2}$ –1 dm. of the surface of the water. *Chaetophora cornu-damae* had almost the same distribution while *Nostoc glomeratum* made its best growth at a depth of 2–4 dm. or even deeper. Evidently it was crowded downward by the Chaetophora with which it grew. Early in the season the Nostoc and Chaetophora grew together. Later the Chaetophora occupied the upper zone while Nostoc grew in equal abundance lower down.

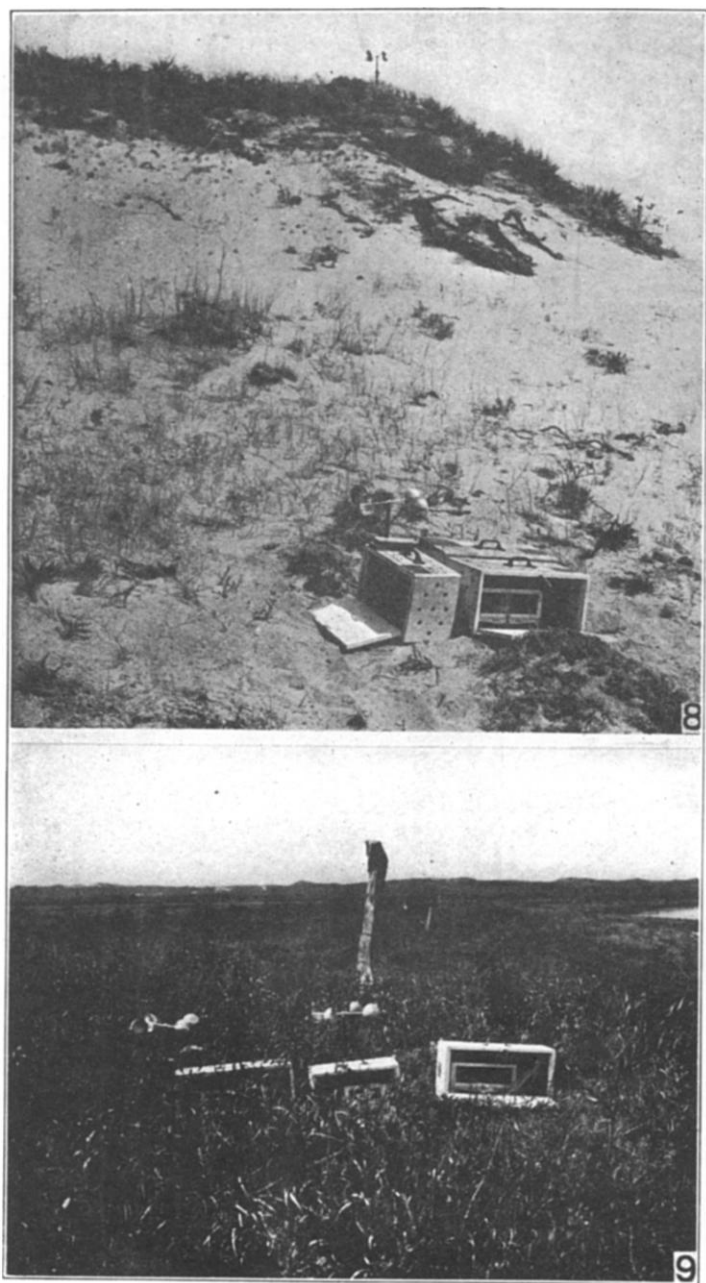


PLATE VII

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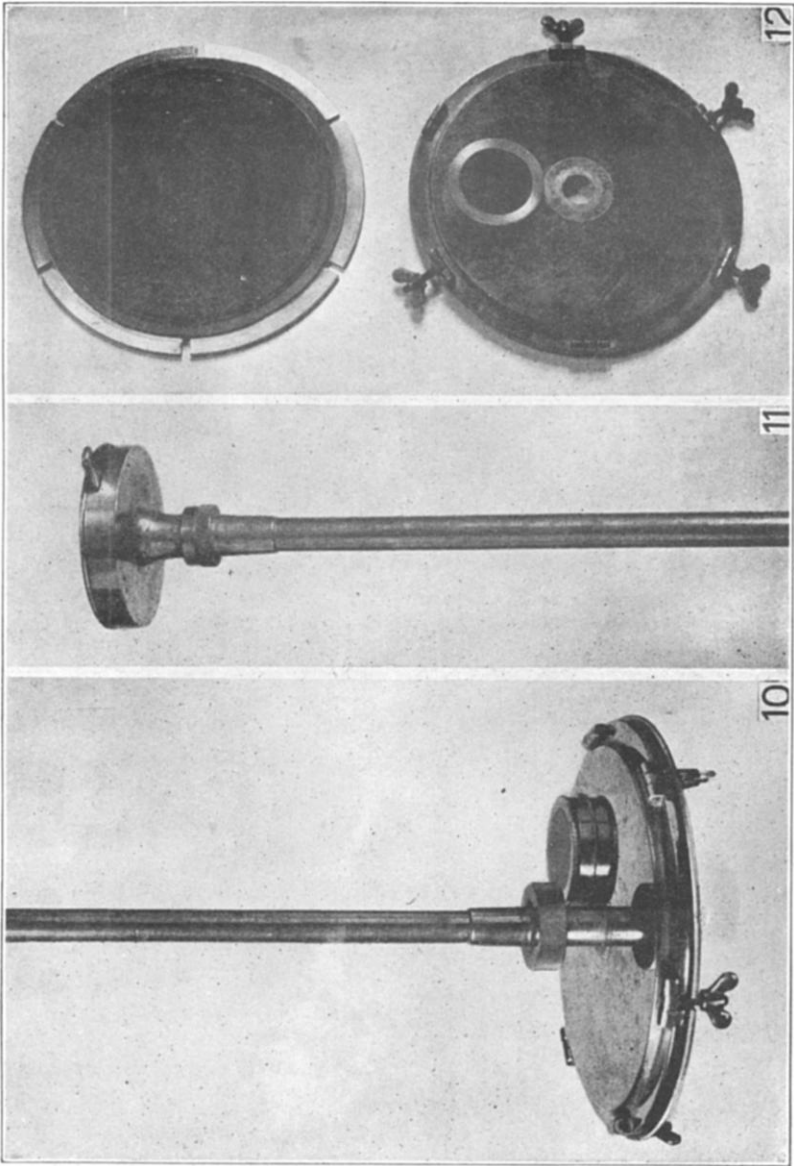


PLATE VIII

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PLATE IX

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The following forms were found floating or attached almost exclusively in the upper two decimeters of water or in water not more than 2 dm. deep.

<i>Clathrocystis aeruginosa</i>	<i>Microspora amoena</i>
<i>Coelosphaerium Kuetszingianum</i>	<i>Chaetophora cornu-damae</i>
<i>Nostoc muscorum</i>	<i>Chaetophora elegans</i>
<i>Nostoc humifusum</i>	<i>Bulbochaete</i> sp.
<i>Nostoc minutum</i>	<i>Oedogonium fragile</i>
<i>Nostoc zetterstedtii</i>	<i>Coleochaete orbicularis</i>
<i>Phormidium tenue</i>	<i>Gongrosira debaryana</i>
<i>Chara contraria</i>	

Mixed with these were most of the unicellular forms of the yellow-green algae and most of the desmids listed for this lake.

Such forms as the following predominated in the deeper water, 2-4 dm. from the surface: *Rivularia natans*, *Rivularia pisum*, *Nostoc glomeratum*, and *Nostoc austinii*. With these were associated *Merismopedium aerugineum*, *Oscillatoria subtilissima*, *Dictyosphaerium pulchellum*, *Gloeocystis gigas*, *Scenedesmus quadricauda*, and *S. bijugatus*. The distribution of unicellular free floating forms, however, was hard to determine because of the constant stirring of the water. It will be noted that few yellow-green algae are characteristically found in the lower zone.

Below a depth of 4 dm. many algae were found but not in any characteristic formation. Evidently they were there because crowded out elsewhere and they were not growing as well as the same species at higher levels.

As to grouping of the algae in these zones it was found that in any given location one or two species were dominant and others grew rather indiscriminately among them. The dominant species was apparently determined by the support on which it grew. In a bed of *Scirpus*, one species of *Chaetophora* and *Nostoc glomeratum* were almost universally the dominating forms, the *Chaetophora* dominating the upper and *Nostoc* the lower zone. On submerged mosses, *Potamogeton*, etc., *Gongrosira debaryana*, *Nostoc glomeratum*, or *Rivularia pisum* dominated, while at the margin of the lake a free floating form as *Nostoc pruniforme* or *Rivularia natans* might dominate. *Clathrocystis aeruginosa* or *Anabaena flos-aquae* usually

dominated the groups floating at the surface of the water, tho the constant winds kept these forms fairly well mixed.

SEASONAL DISTRIBUTION

Careful records of dates of collection were made to determine, so far as possible, the grouping of algae by seasons. As the study extended only from the middle of June until the middle of October, the observations included only summer and fall forms. Only the most general results were obtained. Of the species found in Hackberry lake the members of the Oscillatoriaceae were found only in the early summer, *Merismopedium* and *Coelosphaerium* only in July. Other members of the Myxophyceae were found in early stages in the first part of the season but reached full maturity and maximum abundance in October.

Most of the green algae were found throughout the period observed but they reached their maximum in midsummer except in a few cases. The species of *Gloeocystis* were found early in the summer. *Bulbochaete* was found late in the season (August–October) and the specimens were not fruiting. Nearly all the desmids were found during July. Only a few were present earlier or later in this lake, tho in places near by they occurred at other times in abundance.

The following table shows the forms found in the early, middle, and later summer and suggests something of the seasonal occurrence of the forms.

June 27–July 10	July 10–July 25	July 25–August
<i>Nostoc humifusum</i>	<i>Nostoc zetterstedtii</i>	<i>Nostoc muscorum</i>
<i>Nostoc glomeratum</i>	<i>Nostoc pruniforme</i>	<i>Nostoc minutum</i>
<i>Nostoc austinii</i>	<i>Nostoc humifusum</i>	<i>Nostoc caeruleum</i>
	<i>Nostoc glomeratum</i>	<i>Nostoc pruniforme</i>
		<i>Nostoc glomeratum</i>
<i>Anabaena flos-aquae</i>	<i>Anabaena flos-aquae</i>	<i>Anabaena flos-aquae</i>
<i>Oscillatoria subtilissima</i>		
<i>Phormidium tenue</i>		
<i>Rivularia pisum</i>	<i>Rivularia pisum</i>	<i>Rivularia pisum</i>
<i>Rivularia natans</i> (young)	<i>Rivularia natans</i>	<i>Rivularia natans</i>
	<i>Merismopedium aerugi-</i> <i>neum</i>	
	<i>Coelosphaerium kuetzing-</i> <i>ianum</i>	

June 27-July 10	July 10-July 25	July 25-August
<i>Clathrocystis aeruginosa</i>	<i>Clathrocystis aeruginosa</i>	<i>Clathrocystis aeruginosa</i>
	<i>Staurostrum gracile</i>	
	<i>Spirotaenia obscura</i>	
	<i>Netrium digitus</i>	
	<i>Euastrum oblongum</i>	
<i>Cosmarium vexatum</i>	<i>Cosmarium subcrenatum</i>	
<i>Cosmarium obtusatum</i>	<i>Cosmarium retusifforme</i>	
<i>Cosmarium kjellmani</i> grande		
	<i>Cosmarium obtusatum</i>	
	<i>Cosmarium laeve</i>	
	<i>Cosmarium granatum</i>	
	<i>Cosmarium formosulum</i> nathorstii	
	<i>Cosmarium elfingii</i>	
<i>Closterium lanceolatum</i>	<i>Closterium pritchard-</i> ianum	<i>Closterium moniliferum</i>
	<i>Closterium leibleinii</i>	
<i>Chara contraria</i>	<i>Chara contraria</i>	<i>Chara contraria</i>
<i>Coleochaete orbicularis</i>	<i>Oedogonium fragile</i>	<i>Bulbochaete</i> sp.
	<i>Gongrosira debaryana</i>	
<i>Chaetophora elegans</i>	<i>Chaetophora elegans</i>	<i>Chaetophora elegans</i>
<i>Chaetophora cornu-damae</i>	<i>Chaetophora cornu-damae</i>	<i>Chaetophora cornu-damae</i>
<i>Gloeocystis vesiculosa</i>	<i>Microspora amoena</i>	
<i>Gloeocystis gigas</i>		
<i>Scenedesmus bijugatus</i>	<i>Scenedesmus quadricauda</i>	
	<i>Scenedesmus obliquus</i>	
	<i>Dictyosphaerium pulchellum</i>	
	<i>Pediastrum tetras</i>	
	<i>Pediastrum boryanum</i>	
	<i>Tetraedron trigonum</i>	

A very interesting group of algae was found in a small ditch carrying water from a spring into the northwest end of Hackberry lake. *Closterium lunula* was so dominant here that at first it seemed to be the only species present. Closer examination, however, showed the following species associated with it.

<i>Eremosphaera viridis</i>	<i>Cosmarium umbilicatum</i>
<i>Cylindrospermum majus</i>	<i>Euastrum verrucosum</i>
<i>Cosmarium angulosum concinnum</i>	<i>Pleurotaenium trabecula</i>
<i>Cosmarium circulare</i>	<i>Staurostrum meriani</i>
<i>Cosmarium pachydermum</i>	<i>Staurostrum punctulatum</i>

Phormidium tenue, *P. valderianum*, and *Spirulina major* were found on the lake shore just above the water's edge, making the sand green at many places.

The following algae were found in this lake:

- | | |
|-------------------------------------|--|
| <i>Chroococcaceae</i> | <i>Closterium pritchardianum</i> |
| <i>Clathrocystis aeruginosa</i> | <i>Cosmarium elfingii</i> |
| <i>Coelosphaerium kuetsingianum</i> | <i>Cosmarium formosulum nathrostitii</i> |
| <i>Merismopedium aerugineum</i> | <i>Cosmarium granatum</i> |
| <i>Oscillatoriaceae</i> | <i>Cosmarium kjellmani grande</i> |
| <i>Oscillatoria subtilissima</i> | <i>Cosmarium laeve</i> |
| <i>Phormidium tenue</i> | <i>Cosmarium obtusatum</i> |
| <i>Nostocaceae</i> | <i>Cosmarium retusifforme</i> |
| <i>Anabaena flos-aquae</i> | <i>Cosmarium subcrenatum</i> |
| <i>Cylindrospermum majus</i> | <i>Cosmarium vexatum</i> |
| <i>Nostoc austini</i> | <i>Euastrum oblongum</i> |
| <i>Nostoc caeruleum</i> | <i>Netrium digitus</i> |
| <i>Nostoc glomeratum</i> | <i>Spirotaenia obscura</i> |
| <i>Nostoc humifusum</i> | <i>Staurastrum gracile</i> |
| <i>Nostoc minutum</i> | <i>Tetrasporaceae</i> |
| <i>Nostoc muscorum</i> | <i>Dictyosphaerium pulchellum</i> |
| <i>Nostoc pruniforme</i> | <i>Pleurococcaceae</i> |
| <i>Nostoc zetterstedtii</i> | <i>Scenedesmus bijugatus</i> |
| <i>Rivulariaceae</i> | <i>Scenedesmus obliquus</i> |
| <i>Rivularia natans</i> | <i>Scenedesmus quadricauda</i> |
| <i>Rivularia pisum</i> | <i>Tetraedron trigonum</i> |
| <i>Bacillariaceae</i> | <i>Urococcus insignis</i> |
| <i>Cocconeis placentula</i> | <i>Protococcaceae</i> |
| <i>Cymbella cymbiformis</i> | <i>Gloeocystis gigas</i> |
| <i>Eunotia lunaris</i> | <i>Gloeocystis vesiculosa</i> |
| <i>Fragilaria capucina</i> | <i>Hydrodictyaceae</i> |
| <i>Gomphonema acuminatum</i> | <i>Pediastrum boryanum</i> |
| <i>Gomphonema parvulum</i> | <i>Pediastrum tetras</i> |
| <i>Navicula anglica</i> | <i>Ulotrichaceae</i> |
| <i>Navicula cuspidata</i> | <i>Microspora amoena</i> |
| <i>Navicula dicephala</i> | <i>Chaetophoraceae</i> |
| <i>Navicula sculpta</i> | <i>Chaetophora cornu-damae</i> |
| <i>Navicula subcapitata</i> | <i>Chaetophora elegans</i> |
| <i>Navicula viridis</i> | <i>Gongrosira debaryana</i> |
| <i>Nitzschia spectabilis</i> | <i>Oedogoniaceae</i> |
| <i>Nitzschia tryblionella</i> | <i>Bulbochaete sp.</i> |
| <i>Surirella ovalis pinnata</i> | <i>Oedogonium fragile</i> |
| <i>Desmidiaceae</i> | <i>Coleochaetaceae</i> |
| <i>Closterium lanceolatum</i> | <i>Coleochaete orbicularis</i> |
| <i>Closterium leibleinii</i> | <i>Characeae</i> |
| <i>Closterium moniliferum</i> | <i>Chara contraria</i> |

CLEAR LAKE

This lake (Fig. 1, 2, 13) is a little wider and deeper than Hackberry lake and is about two-thirds of a mile distant from it. The water, however, is very alkaline (see discussion of alkalinity) and of a characteristic yellowish color. About the edge in places were rushes but there was little other vegetation in the lake. The algal flora was scarce in species but rich in individuals. Throughout the season the water was full of *Closterium aciculare*.¹ With this were found a few specimens of *Cosmarium obtusatum* and *Pediastrum boryanum*, and a few diatoms in fair abundance but that was all. Since in Clear lake the algae were all free floating, and the species were limited, no distribution studies were attempted. The same species were found throughout the summer. *Closterium aciculare* was the only characteristic form and was present throughout the season. The few other forms present with it were characteristic of the springs flowing into the lake and probably all came there by chance. It is probable that they could not have continued to live in so alkaline a water. Only one factor, alkalinity, could have influenced the algal flora of this lake.

In some places on the shore of the lake were springs whose water contained the richest algal flora found in the lake region. This was especially true at the west end (x in Fig. 13). Here the springs were on the sloping bank and the water seeped slowly down through the boggy soil. The surface was covered with grass and ferns forming sod enough to nearly support a hundred weight or more. Cattle coming to the spring for water had tramped over this sod forming holes from the size of a footprint to two or three feet in diameter. In these holes (Fig. 14) the water stood undisturbed for long periods with the thick grass sheltering the surface from the wind. The result was a large number of small aquaria. The water in these was kept uniformly fresh by seepage from the springs. While no chemical analysis was made, it was noticeable that the alkalinity was low.

¹ This form in size fits the description of the species as given by West and West (51) but may be the form referred to by West (50) as *Closteriopsis longissima* tho some of the specimens were over 600 μ long and 7 μ wide. He suggests that *Closteriopsis* may be a degenerate of *Closterium aciculare* var. *subprorum*.

The temperature was fairly uniform throughout the summer period varying from about 68° F. in the early morning to about 80° F. at 3 p.m. So far as was observed the ecological conditions in the various pockets were remarkably uniform in every way. Each was dominated by some one species, the usual dominants being *Anabaena torulosa*, various species of *Nostoc*, *Spirogyra*, *Scytonema*, *Oedogonium*, and *Mougeotia*. With these were mixed in various proportions the other species found. Attempts were made to determine whether there was any uniformity as to the species present with a given dominant but there seemed to be none.

The only ecological groupings of forms observed were seasonal. As will be seen from the accompanying list some forms were found only early in the summer, others late in the summer, and still others in the fall. The greatest variety of species was found in the middle of the summer. In the case of unicellular forms this list can only be looked upon as suggestive. Only a few specimens are found for some of them and chance in collecting may have caused others to be overlooked in one period or another. In this table early summer means from the middle of June to the middle of July; midsummer from the middle of July to the middle of August; fall is represented by collections made in October. Here fresh water, uniform temperature, protection from wind, and very shallow water form a habitat as uniform in every respect as is possible. Here the dominant forms found in a given water pocket can be due only to one of two things, seasonal periodicity which was very evident and the chance dominance of certain forms. Often the soil beneath a mass of *Spirogyra*, *Mougeotia*, or other such form was covered with desmids or diatoms. It is apparent that smaller forms, especially unicellular ones, may be shaded by the dominant species and hence their presence would be determined by their light relation. However, which of these shade loving forms should be associated with a given dominant species was chance so far as was determined. At other places on the lake shore were springs where a few algae were found but they were of so little consequence that the species were included only in the general list of species.

CLEAR LAKE PUDDLES

	Early summer	Mid- summer	October
<i>Chroococcaceae</i>			
<i>Aphanothece prasina</i>		x	
<i>Clathrocystis aeruginosa</i>		x	
<i>Gloeocapsa arenaria</i>		x	
<i>Oscillatoriaceae</i>			
<i>Oscillatoria formosa</i>		x	
<i>Oscillatoria limosa</i>	x		x
<i>Phormidium tenue</i>		x	
<i>Phormidium valderianum</i>		x	
<i>Nostocaceae</i>			
<i>Anabaena flos-aquae</i>	x	x	
<i>Anabaena oscillarioides</i>		x	
<i>Anabaena torulosa</i>	x	x	x
<i>Cylindrospermum comatum</i>			x
<i>Nodularia harveyana</i>		x	
<i>Nostoc linckia</i>	x		x
<i>Nostoc minutum</i>		x	
<i>Nostoc muscorum</i>	x	x	
<i>Nostoc spongiaeforme</i>	x		
<i>Scytonemaceae</i>			
<i>Scytonema crispum</i>	x	x	x
<i>Rivulariaceae</i>			
<i>Rivularia natans</i>			x

*Bacillariaceae**

Achnanthes lanceolata
Cyclotella meneghiniana
Cymbella amphicephala
Cymbella cuspidata
Cymbella naviculiformis
Cymbella subaequalis
Cystopleura gibba
Cystopleura gibba ventricosa

Cystopleura zebra

Eunotia diodon
Eunotia lunaris
Eunotia major
Fragilaria construens
Gomphonema acuminatum
Gomphonema constrictum
Gomphonema gracile
Gomphonema montanum

* No seasonal studies were made of diatoms.

Melosira varians	Navicula pupula
Navicula ambigua	Navicula sculpta
Navicula anglica	Navicula sphaerophora
Navicula bacilliformis	Navicula stauroptera
Navicula brebissonii	Navicula viridis
Navicula cuspidata	Nitzschia brebissonii
Navicula dicephala	Stauroneis anceps
Navicula elliptica	Stauroneis anceps amphicephala
Navicula gibba brevistriata	Stauroneis phoenicenteron
Navicula hilseana	Surirella ovalis ovata
Navicula major	Synedra rumpens
Navicula mesolepta	Synedra ulna
Navicula iridis	

	Early summer	Mid- summer	October
<i>Desmidiaceae</i>			
<i>Arthrodesmus convergens</i>	x	x	x
<i>Closterium cynthia</i>	x	x	x
<i>Closterium didymotocum</i>	x		
<i>Closterium jenneri</i>	x		
<i>Closterium lanceolatum</i>			x
<i>Closterium lunula</i>	x	x	x
<i>Closterium moniliferum</i>	x	x	x
<i>Closterium parvulum</i>		x	x
<i>Closterium pritchardianum</i>			x
<i>Closterium siliqua</i>			x
<i>Closterium striolatum</i>	x		
<i>Closterium turgidum</i>	x		
<i>Cosmarium abruptum</i>		x	
<i>Cosmarium angulosum</i>			x
<i>Cosmarium angulosum concinnum</i>		x	x
<i>Cosmarium boeckii</i>	x		x
<i>Cosmarium blyttii</i>		x	x
<i>Cosmarium botrytis tumidum</i>	x		
<i>Cosmarium circulare</i>	x		x
<i>Cosmarium connatum</i>	x	x	x
<i>Cosmarium crenatum</i>	x		
<i>Cosmarium cyclicum</i>	x		
<i>Cosmarium cymatopleurum</i>	x		
<i>Cosmarium formosulum nathrostii</i>		x	x
<i>Cosmarium galeritum</i>		x	
<i>Cosmarium granatum</i>		x	x

	Early summer	Mid- summer	October
<i>Cosmarium holmiense</i>	x		x
<i>Cosmarium jkellmani grande</i>		x	
<i>Cosmarium meneghinii</i>		x	
<i>Cosmarium microsphinctum</i>	x		
<i>Cosmarium notabile</i>	x		
<i>Cosmarium obtusatum</i>	x		
<i>Cosmarium ochthodes</i>		x	
<i>Cosmarium pachydermum</i>		x	x
<i>Cosmarium pachydermum aethiopicum</i> ..	x		x
<i>Cosmarium phaseolus elevatum</i>		x	
<i>Cosmarium phaseolus forma minor</i>	x		
<i>Cosmarium portianum</i>	x		x
<i>Cosmarium pygmaeum</i>	x		
<i>Cosmarium pyramidatum</i>		x	x
<i>Cosmarium rectangulare hexagonum</i>		x	x
<i>Cosmarium sportella</i>		x	
<i>Cosmarium subcrenatum</i>	x	x	
<i>Cosmarium subtumidum</i>		x	
<i>Cosmarium subundulatum</i>	x		
<i>Cosmarium taxichondrum</i>		x	
<i>Cosmarium tetraophthalmum</i>		x	
<i>Cosmarium triobulatum</i>		x	
<i>Cosmarium tumidum</i>		x	
<i>Cosmarium vexatum</i>		x	
<i>Euastrum attenuatum</i>			x
<i>Euastrum bidentatum</i>		x	
<i>Euastrum binale</i>		x	x
<i>Euastrum dubium</i>		x	
<i>Euastrum oblongum</i>		x	x
<i>Euastrum verrucosum</i>	x	x	x
<i>Euastrum verrucosum alatum</i>		x	x
<i>Micrasterias pinnatifida</i>		x	x
<i>Micrasterias rotata</i>			x
<i>Netrium digitus</i>		x	x
<i>Netrium interruptum</i>			x
<i>Penium libellula intermedium</i>			x
<i>Penium naegeli</i>		x	
<i>Penium spirotriolatum</i>		x	x
<i>Pleurotaenium coronatum</i>	x	x	x
<i>Pleurotaenium nodulosum</i>		x	
<i>Pleurotaenium trabeculata</i>	x		

	Early summer	Mid- summer	October
<i>Spirotaenia condensata</i>		x	x
<i>Spirotaenia trabeculata</i>		x	
<i>Staurastrum alternans</i>			x
<i>Staurastrum dickiei</i>		x	x
<i>Staurastrum dilatatum</i>			x
<i>Staurastrum dispar</i>		x	
<i>Staurastrum hirsutum</i>		x	x
<i>Staurastrum margaritaceum</i>		x	x
<i>Staurastrum meriani</i>			x
<i>Staurastrum muticum</i>		x	
<i>Staurastrum orbiculare</i>	x	x	x
<i>Staurastrum orbiculare ralfsii</i>		x	
<i>Staurastrum paxilliferum</i>			x
<i>Staurastrum polytrichum</i>	x		
<i>Staurastrum punctulatum</i>	x	x	x
<i>Staurastrum saxonicum</i>		x	
<i>Staurastrum teliferum</i>		x	
<i>Zygnemaceae</i>			
<i>Spirogyra arcta catenaeformis</i>	x		
<i>Spirogyra crassa</i>	x		
<i>Spirogyra dubia</i>	x	x	x
<i>Spirogyra lutetiana</i>	x		
<i>Spirogyra neglecta</i>			x
<i>Spirogyra varians</i>			x
<i>Zygnema</i> sp.	x	x	x
<i>Mesocarpaceae</i>			
<i>Mougeotia robusta</i>			x
<i>Mougeotia scalaris</i>			x
<i>Mougeotia viridis</i>	x		
<i>Volvocaceae</i>			
<i>Volvox aureus</i>		x	
<i>Tetrasporaceae</i>			
<i>Dictyosphaerium pulchellum</i>		x	x
<i>Tetraspora gelatinosa</i>	x		

	Early summer	Mid- summer	October
<i>Pleurococcaceae</i>			
<i>Crucigenia rectangularis</i>			x
<i>Eremosphaera viridis</i>		x	x
<i>Nephrocytium naegelii</i>	x		
<i>Oocystis solitaria</i>		x	x
<i>Rhaphidium polymorphum falcatum</i>		x	x
<i>Scenedesmus antennatus</i>	x		
<i>Scenedesmus bijugatus</i>	x		x
<i>Tetraedron reticulatum</i>			x
<i>Urococcus insignis</i>			x
<i>Prolococcaceae</i>			
<i>Gloeocystis vesiculosa</i>	x		
<i>Ophiocytium capitatum</i>			x
<i>Hydrodictyaceae</i>			
<i>Coelastrum sphaericum</i>		x	
<i>Pediastrum angulosum</i>			x
<i>Pediastrum boryanum</i>	x	x	x
<i>Pediastrum tetras</i>		x	
<i>Ulotrichaceae</i>			
<i>Microspora pachyderma</i>		x	
<i>Microspora stagnorum</i>		x	
<i>Chaetophoraceae</i>			
<i>Stigeoclonium glomeratum</i>	x		
<i>Oedogoniaceae</i>			
<i>Bulbochaete</i> sp.....			x
<i>Oedogonium</i> sp.....	x	x	x
<i>Oedogonium capilliforme australe</i>		x	
<i>Oedogonium cardiacum</i>	x		
<i>Oedogonium crispum uruguayense</i>	x		
<i>Oedogonium fragile</i>		x	
<i>Oedogonium varians</i>			x
<i>Cladophoraceae</i>			
<i>Rhizoclonium hieroglyphicum</i>	x		

	Early summer	Mid- summer	October
<i>Vaucheriaceae</i>			
<i>Vaucheria</i> sp.			x

BIG ALKALI LAKE

Big Alkali Lake (Fig. 1) is a little larger than Clear lake. While it is more alkaline than Hackberry, Dewey, or Watts, it is far less so than Clear lake. The water had the characteristic yellow color of the alkaline lakes of this region. Here again alkalinity must be given as the factor governing the algal flora of the lake. One visit only was made here. At first sight the water seemed absolutely barren but further investigation showed the following forms to be present. The *Chara* was quite abundant forming very much dwarfed patches on the bottom near the shore.

<i>Chroococcaceae</i>	<i>Cosmarium granatum</i>
<i>Clathrocystis aeruginosa</i>	<i>Cosmarium meneghinii</i>
<i>Merismopedium glaucum</i>	<i>Cosmarium sexnotatum</i>
<i>Merismopedium tenuissimum</i>	<i>Staurastrum gracile</i>
<i>Oscillatoriaceae</i>	<i>Staurastrum paradoxum</i>
<i>Oscillatoria limosa</i>	<i>Staurastrum polymorphum</i>
<i>Bacillariaceae</i>	<i>Tetrasporaceae</i>
<i>Amphora ovalis</i>	<i>Dictyosphaerium pulchellum</i>
<i>Campylodiscus clypeus</i>	<i>Pleurococcaceae</i>
<i>Cymbella cistula</i>	<i>Scenedesmus bijugatus</i>
<i>Cystopleura gibba</i>	<i>Scenedesmus obliquus</i>
<i>Navicula cryptocephala veneta</i>	<i>Scenedesmus quadricauda</i>
<i>Navicula gastrum</i>	<i>Hydrodictyceae</i>
<i>Navicula oblonga</i>	<i>Pediastrum boryanum</i>
<i>Navicula sculpta</i>	<i>Pediastrum duplex clathratum</i>
<i>Desmidiaceae</i>	<i>Characeae</i>
<i>Cosmarium angulosum</i>	<i>Chara foetida rabenhorstii</i>

DEWEY LAKE

Dewey lake (Fig. 1) is situated about half a mile from Hackberry lake. It is less alkaline, nearly three times as large and proportionally deeper. Otherwise the conditions were much the same. Temperatures taken in the region of algal growth showed little variation from those in Hackberry lake.

The algae were found along the margins of the lake and attached to submerged plants near the surface. As no attempt was made to study conditions in this lake no explanation of the conspicuous difference in the forms found can be given unless it was the larger amount of water and difference in alkalinity. Collections were made here at irregular intervals and the list must not be looked upon as complete.

Chroococcaceae

Clathrocystis aeruginosa
Merismopedium glaucum

Oscillatoriaceae

Beggiatoa alba
Lyngbya aerugineo-caerulea
Oscillatoria amphibia
Oscillatoria formosa
Oscillatoria subtilissima
Phormidium fragile
Phormidium tenue
Phormidium valderianum

Nostocaceae

Anabaena flos-aquae
Nostoc linckia
Nostoc pruniforme

Scytonemaceae

Tolypothrix distorta

Rivulariaceae

Rivularia echinulata
Rivularia natans

Bacillariaceae

Amorpha ovalis
Brebissonia vulgaris
Cocconeis placentula
Cymbella cistula
Cymbella cuspidata
Cymbella lanceolata
Encyonema turgidum
Eunotia lunaris
Fragilaria capucina
Fragilaria construens binodis
Gomphonema constrictum
Gomphonema gracile
Gomphonema montanum
Gomphonema parvulum
Navicula cuspidata

Navicula lanceolata

Navicula major
Navicula oblonga
Navicula pupula
Staureneis acuta
Staureneis smithii
Staureneis tenuissima
Synedra rumpens
Synedra ulna

Desmidiaceae

Closterium pritchardianum
Cosmarium blyttii
Cosmarium boeckii
Cosmarium formosulum nathorstii
Cosmarium impressulum
Cosmarium obtusatum
Cosmarium ochthodes var.
Cosmarium subcrenatum
Cosmarium turpinii podolicum
Cosmarium vexatum
Penium margaritaceum
Staurostrum orbiculare

Pleurococcaceae

Scenedesmus bijugatus
Scenedesmus obliquus
Tetraedron trigonum

Protococcaceae

Characium ambiguum
Characium subulatum
Gloeocystis vesiculosa

Hydrodictyaceae

Pediastrum boryanum

Ulotrichaceae

Hormiscia subtilis variabilis

Chaetophoraceae

Chaetophora elegans
Gongrosira debaryana
Stigeoclonium aestivale

Stigeoclonium glomeratum
Oedogoniaceae
 Oedogonium grande

Oedogonium vaucherii
Helminthocladiaceae
 Batrachospermum vagum

WATTS LAKE

Watts lake (Fig. 1) is about half the size of Hackberry and only about one-third of a mile from it. Conditions in the lake were very similar to those in Hackberry in every respect. It was, however, slightly less alkaline than Dewey lake.

Collections were made here about once a week but other data were not taken. No boat was available on this lake and that may account for some of the difference in the reports for Watts and Hackberry lakes. No reason for a difference in species could be given unless it were the slight difference in alkalinity. The following species were found which it will be noted are nearly all included in those found in Hackberry and Dewey lakes and the springs on the shore of Clear lake.

Chroococcaceae
 Clathrocystis aeruginosa
 Coelosphaerium kuetzingianum
 Merismopedium tenuissimum
 Microcystis marginata

Nostocaceae
 Nostoc pruniforme

Bacillariaceae
 Achnanthes lanceolata
 Amphora ovalis
 Cocconeis placentula
 Gomphonema gracile
 Gomphonema montanum
 Homoeocladia amphioxys
 Navicula gastrum
 Navicula lanceolata

Desmidiaceae
 Cosmarium boeckii
 Cosmarium formosulum nathorstii

Cosmarium geminatum
 Cosmarium granatum
 Cosmarium obtusatum
 Cosmarium phaseolus
 Cosmarium pseudopyramidatum
 Cosmarium subcrenatum
 Staurastrum gracile
 Staurastrum margaritaceum

Tetrasporaceae
 Dictyosphaerium pulchellum

Pleurococcaceae
 Oocystis solitaria
 Scenedesmus bijugatus
 Scenedesmus obliquus
 Scenedesmus quadricauda
 Tetraedron minimum

Hydrodictyceae
 Pediastrum boryanum

Characeae
 Chara contraria

OTHER LAKES

One visit was made to each of the following lakes in the early summer. Trout and Dad's lakes (Fig. 1) are among the larger of the

group while *Phalaris* (Fig. 1) is one of the smaller. The Snake Creek Falls, about 15 miles distant, were visited once. These are falls in a creek which flows through the sandhill region. These collections were made so superficially that the lists must stand only as representing some species found in these localities.

The only form found which was sufficiently conspicuous to need special mention was *Nostoc verrucosum* which was extremely abundant on rocks in the cataract below the falls in Snake Creek.

The forms found in these localities are as follows:

PHALARIS LAKE

Chroococcaceae

Coelosphaerium kuetzingianum
Merismopedium tenuissimum
Dactylococcopsis raphidioides

Bacillariaceae

Amphora ovalis
Cocconeis placentula
Cystopleura gibba
Cystopleura turgida
Gomphonema montanum
Homoeocladia amphibia
Navicula cryptocephala veneta
Navicula cuspidata
Navicula elliptica
Navicula gastrum
Navicula oblonga
Navicula sculpta
Navicula sphaerophora
Sceptroneis fibula

Desmidiaceae

Cosmarium angulosum
Cosmarium blyttii
Cosmarium formosulum nathorstii
Cosmarium granatum subgranatum
Cosmarium obtusatum
Cosmarium regnellii

Tetrasporaceae

Dictyosphaerium pulchellum

Pleurococcaceae

Oocystis solitaria
Pediastrum boryanum
Scenedesmus bijugatus
Scenedesmus quadricauda
Tetraedron minimum

Characeae

Chara contraria
Chara evoluta
Chara fragilis
Chara sp.

TROUT LAKE

Chroococcaceae

Clathrocystis aeruginosa

Nostocaceae

Anabaena flos-aquae
Nostoc zetterstedtii

Hydrodictyaceae

Pediastrum angulosum

Characeae

Chara sp.

DAD'S LAKE

Chroococcaceae

Clathrocystis aeruginosa

Desmidiaceae

Closterium acerosum

Tetrasporaceae

Dictyosphaerium pulchellum

Hydrodictyaceae

Pediastrum boryanum
Pediastrum duplex clathratum

SNAKE FALLS

Chroococcaceae

Merismopedium glaucum

Oscillatoriaceae

Arthrospira jenneri

Oscillatoria brevis

Oscillatoria formosa

Phormidium retzii

Nostocaceae

Nostoc pruniforme

Nostoc verrucosum

Rivulariaceae

Calothrix parietina

Bacillariaceae

Achnanthes lanceolata

Amphora ovalis

Cocconeis placentula

Cymbella amphicephala

Cymbella cuspidata

Cymbella ehrenbergii

Cymbella gastroides

Cystopleura gibba

Cystopleura ocellata

Cystopleura turgida

Cystopleura zebra

Denticula elegans

Encyonema turgidum

Eunotia major

Fragilaria mutabilis

Gomphonema acuminatum

Gomphonema herculeanum

Lysigonium crenulatum

Lysigonium distans

Navicula ambigua

Navicula anglica

Navicula appendiculata

Navicula brebissonii

Navicula cuspidata craticula

Navicula dicephala

Navicula elliptica

Navicula humilis

Navicula iridis

Navicula lanceolata

Navicula limosa

Navicula gibba brevistriata

Navicula mesolepta

Navicula pupula

Navicula radiosa

Navicula sculpta

Navicula viridis

Homoeocladia amphibia

Homoeocladia brebissonii

Homoeocladia amphioxys

Homoeocladia palea

Rhoicosphenia curvata

Sceptroneis pacifica

Stauroneis anceps

Stauroneis phoenicenteron

Surirella robusta

Surirella spiralis

Synedra ulna

Tetracyclus lacustris

Desmidiaceae

Closterium striolatum

Cosmarium microsphinctum

Cosmarium portianum

Cosmarium sportella

Cosmarium undulatum wollei

Euastrum oblongum

Euastrum verrucosum

Penium margaritaceum

Staurostrum orbiculare hibernicum

Pleurococcaceae

Scenedesmus obliquus

Protococcaceae

Chlorococcum humicola

Cladophoraceae

Cladophora glomerata

CONCLUSION

It appears even from so brief a study as the one just described that the occurrence of algae in a given body of water at a given time is

due, to a certain extent, as Transeau (44), West (49), and others have said, to seasonal periodicity.

It is also evident that West (48 and 50), Oltmanns (34), Brannon (12), Wipple and Parker (53), Chambers (15), and many others are correct in their decisions that the mineral and gas content of water has much to do with its algal flora. Of these factors, alkalinity is probably to a great extent, the explanation for the wide difference in the algal flora of lakes so close together and so uniform in all other factors.

In a given lake the distribution of species may be explained by the one factor only that is variable, namely light intensity. Means for measuring this factor were entirely inefficient and only the crudest estimates can be made.

In small bodies of water where even the light is not variable to any measurable degree the dominant species and its associates are determined merely by chance except that forms lying beneath other forms are more shaded. This exception does not affect the dominant species but may affect the forms associated with it.

ALGAE FOUND IN CHERRY COUNTY

Chroococcaceae.

Aphanothece prasina A. Braun

Clathrocystis aeruginosa (Kuetz.)

Henfrey

Coelosphaerium kuetzingianum Naeg.

Dactylococcopsis raphidioides Hansg.

Gloeocapsa arenaria (Hassall) Rabenh.

Merismopedium aerugineum Bréb.

Merismopedium glaucum (Ehrb.)

Naeg.

Merismopedium tenuissimum Lem-
mer.

Microcystis marginata (Menegh.)
Kuetz.

Oscillatoriaceae.

Arthrospira jenneri (Kuetz.) Stiz.

Lyngbya aerugineo-caerulea (Kuetz.)
Gom.

Oscillatoria amphibia Ag.

Oscillatoria brevis (Kuetz.) Gom.

Oscillatoria formosa Bory.

Oscillatoria limosa. (Roth) Ag.

Oscillatoria princeps Vauch.

Oscillatoria sancta (Kuetz.) Gom.

Oscillatoria subtilissima Kuetz.

Oscillatoria tenuis Ag.

Phormidium fragile (Menegh.) Gom.

Phormidium retzii (Ag.) Gom.

Phormidium tenue (Menegh.) Gom.

Phormidium valderianum (Delp.)
Gom.

Spirulina major Kuetz.

Nostocaceae.

Anabaena flos-aquae (Lyngb.) Bréb.

Anabaena oscillarioides Bory.

Anabaena torulosa (Carmich.) Lager-
heim

Cylindrospermum comatum Wood

Cylindrospermum majus Kuetz.

Nodularia harveyana (Thwaites) Thuret

Nostoc austini Wood

Nostoc caeruleum Lyngbye

- Nostoc commune* Vaucher
Nostoc glomeratum Kuetz.
Nostoc humifusum Carmichael
Nostoc linckia (Roth) Bornet
Nostoc minutum Desm.
Nostoc muscorum Ag.
Nostoc pruniforme (L.) Ag.
Nostoc spongiaeforme Ag.
Nostoc verrucosum (L.) Vauch.
Nostoc zetterstedtii Areschoug
 Scytonemaceae.
Scytonema crispum (Ag.) Bornet
Tolypothrix distorta (Hofm. B.) Kuetz.
 Rivulariaceae.
Calothrix parietina (Naeg.) Thur.
Rivularia echinulata (Smith) Born
Rivularia natans (Hedw.) Welw.
Rivularia pisum Ag.
 Bacillariaceae.
Achnanthes lanceolata (Bréb.) Gr.
Amorpha ovalis (Bréb.) Kuetz.
Brebissonia vulgaris (Thwait) Kunze
Campylodiscus clypeus Ehr.
Cocconeis placentula Ehr.
Cyclotella meneghiniana Kuetz.
Cymbella amphicephala Naeg.
Cymbella cistula (Hempr.) Kirchn.
Cymbella cuspidata Kuetz.
Cymbella cymbiformis (Kuetz.) Bréb.
Cymbella ehrenbergii Kuetz.
Cymbella lanceolata (Ehr.) Kirch.
Cymbella naviculiformis Auersw.
Cymbella subaequalis Grun.
Cystopleura gibba (Ehr.) Kunze
Cystopleura zebra (Ehr.) Kunze
Encyonema turgidum (Greg.) Grun.
Eunotia diodon Ehr.
Eunotia lunaris Grun.
Eunotia major (W. Sm.) Rabenh.
Fragilaria capucina Desmaz.
Fragilaria construens (Ehr.) Grun.
Fragilaria construens binodis (Ehr.) Grun.
Gomphonema acuminatum Ehr.
Gomphonema constrictum Ehr.
Gomphonema gracile Ehr.
Gomphonema herculeanum Ehr.
Gomphonema montanum Schum.
Gomphonema parvulum Kuetz.
Homoeocladia amphibia (Grun.) Kunze
Homoeocladia amphioxys (Ehr.) Kunze
Homoeocladia brebissonii (H. Sm.) Kunze
Homoeocladia palea (Kuetz.) Kunze
Lysigonium crenulatum (Kuetz.) Kunze
Lysigonium distans (Kuetz.) Kunze
Lysigonium varians (Ag.) D.T.
Navicula ambigua Ehr.
Navicula anglica Ralfs
Navicula appendiculata (Ag.) Kuetz.
Navicula bacilliformis Grun.
Navicula brebissonii Kuetz.
Navicula cryptocephala veneta (Kuetz.) Rabenh.
Navicula cuspidata Kuetz.
Navicula dicephala Ehr.
Navicula elliptica Kuetz.
Navicula gastrum Ehr.
Navicula gibba (Ehr.) Kuetz.
Navicula gibba brevistriata Grim.
Navicula hilseana Jan.
Navicula humilis Donk.
Navicula iridis Ehr.
Navicula lanceolata Kuetz.
Navicula limosa Kuetz.
Navicula major Kuetz.
Navicula mesolepta Ehr.
Navicula oblonga Kuetz.
Navicula pupula Kuetz.
Navicula radiosa Kuetz.
Navicula sculpta Ehr.
Navicula sphaerophora Kuetz.
Navicula stauroptera Grun.
Navicula subcapitata Greg.
Navicula viridis Kuetz.
Nitzschia brebissonii W. Sm.
Nitzschia spectabilis (Ehr.) Ralfs
Nitzschia tryblionella Hantzsch.
Rhoicosphenia curvata Grun.
Sceptroneis fibula (Bréb.) Schuett

- Sceptroneis pacifica* (Grun.) Elmore (In press)
Stauroneis anceps Ehr.
Stauroneis anceps amphi-cephala Kuetz.
Stauroneis acuta W. Sm.
Stauroneis phoenicenteron Ehr.
Stauroneis smithii Grun.
Surirella ovalis ovata (Bréb.) V.H.
Surirella ovalis pinnata (Bréb.) V.H.
Surirella robusta Ehr.
Surirella spiralis Kuetz.
Synedra rumpens Kuetz.
Synedra ulna (Nitzsch.) Ehr.
Tetracyclus lacustris Ralfs
 Desmidiaceae.
Arthrodesmus convergens Ehrenb.
Closterium acerosum (Schrank) Ehrenb.
Closterium aciculare Tuffen West
Closterium cynthia DeNot.
Closterium didymotocum Corda
Closterium jenneri Ralfs
Closterium lanceolatum Kuetz.
Closterium leibleinii Kuetz.
Closterium lunula (Muell.) Nitzsch.
Closterium moniliferum (Bory.) Ehrenb.
Closterium parvulum Naeg.
Closterium pritchardianum Arch.
Closterium siliqua West and G. S. West
Closterium striolatum Ehrenb.
Closterium turgidum Ehrenb.
Cosmarium abruptum Lund.
Cosmarium angulosum Bréb.
Cosmarium angulosum concinnum (Rabenh.) West and G. S. West
Cosmarium blyttii Wille
Cosmarium boeckii Wille
Cosmarium botrytis tumidum Wolle
Cosmarium circulare Reinsch.
Cosmarium connatum Bréb.
Cosmarium crenatum Ralfs
Cosmarium cyclicum Lund.
Cosmarium cymatopleurum Nordst.
Cosmarium elfingii Racib.
Cosmarium formosulum nathorstii (Boldt) West and G. S. West
Cosmarium galeritum Nordst.
Cosmarium geminatum Lund.
Cosmarium granatum Bréb.
Cosmarium granatum subgranatum Nordst.
Cosmarium holmiense Lund.
Cosmarium holmiense integrum Lund.
Cosmarium impressulum Elfv.
Cosmarium kjellmani grande Wille
Cosmarium laeve Rabenh.
Cosmarium meneghinii Bréb.
Cosmarium microsphinctum Nordst.
Cosmarium notabile Bréb.
Cosmarium obtusatum Schmidle
Cosmarium ochthodes Nordst. var.
Cosmarium pachydermum Lund.
Cosmarium pachydermum aethiopicum West and G. S. West
Cosmarium phaseolus Bréb.
Cosmarium phaseolus elevatum Nordst.
Cosmarium phaseolus minor Boldt
Cosmarium portianum Arch.
Cosmarium protractum (Naeg.) De-Bary
Cosmarium pseudopyramidatum Lund.
Cosmarium pygmaeum Arch.
Cosmarium pyramidatum Bréb.
Cosmarium rectangulare hexagonum (Elf.) West and G. S. West
Cosmarium regnellii Wille
Cosmarium retusifforme (Wille) Gutw.
Cosmarium sexnotatum Gutw.
Cosmarium sportella Bréb.
Cosmarium subcrenatum Hantzsch
Cosmarium subtumidum Nordst.
Cosmarium subundulatum Wille
Cosmarium taxichondrum Lund.
Cosmarium tetraophthalmum Bréb.
Cosmarium trilobulatum Reinsch
Cosmarium tumidum Lund.
Cosmarium turpinii podolicum Gutw.
Cosmarium umbilicatum Luetkem.

- Cosmarium undulatum wollei* West
Cosmarium vexatum West
Euastrum attenuatum Wolle
Euastrum bidentatum Naeg.
Euastrum binale (Turp.) Ehrenb.
Euastrum dubium Naeg.
Euastrum oblongum (Grev.) Ralfs
Euastrum verrucosum Ehrenb.
Euastrum verrucosum alatum Wolle
Micrasterias pinnatifida (Kuetz.) Ralfs
Micrasterias rotata (Grev.) Ralfs
Netrium digitus (Ehrenb.) Itzigs and Rothe
Netrium interruptum (Bréb.) Luetkem.
Pleurotaenium coronatum (Bréb.) Rabenh.
Penium libellula (Focke) Nordst.
Penium margaritaceum (Ehrenb.) Bréb.
Penium naegelii Bréb.
Penium spirostriolatum Barker
Pleurotaenium nodulosum (Bréb.) DeBary
Pleurotaenium trabecula (Ehrenb.) Naeg.
Spirotaenia condensata Bréb.
Spirotaenia obscura Ralfs
Spirotaenia trabeculata A. Br.
Staurastrum alternans Bréb.
Staurastrum dickiei Ralfs
Staurastrum dilatatum Ehrenb.
Staurastrum dispar Bréb.
Staurastrum gracile Ralfs
Staurastrum hirsutum (Ehrenb.) Bréb.
Staurastrum margaritaceum Ehrenb.
Staurastrum meriani Reinsch
Staurastrum muticum Bréb.
Staurastrum orbiculare (Ehrenb.) Ralfs
Staurastrum orbiculare hibernicum West and G. S. West
Staurastrum orbiculare ralfsii West and G. S. West
Staurastrum paradoxum Meyen
Staurastrum paxilliferum G. S. West
Staurastrum polymorphum Bréb.
Staurastrum punctulatum Bréb.
Staurastrum saxonicum Bulnh.
Staurastrum teliferum Ralfs
 Zygnemaceae.
Spirogyra arcta catenaeformis Kirchn.
Spirogyra crassa Kuetz.
Spirogyra dubia Kuetz.
Spirogyra lutetiana Petit
Spirogyra neglecta (Hass.) Kuetz.
Spirogyra varians (Hass.) Kuetz.
Zygnema Ag. sp.
 Mesocarpaceae.
Mougeotia robusta (DeBary) Wittr.
Mougeotia scalaris Hass.
Mougeotia viridis (Kuetz.) Wittr.
 Volvocaceae.
Volvox aureus Ehrenb.
 Tetrasporaceae.
Tetraspora gelatinosa (Vauch.) Desv.
Dictyosphaerium pulchellum Wood
 Pleurococcaceae.
Crucigenia rectangularis (A. Br.) Gay
Eremosphaera viridis DeBary
Nephrocytium naegelii Grun.
Oocystis solitaria Wittr.
Raphidium polymorphum falcatum (Corda) Rabenh.
Scenedesmus antennatus Bréb.
Scenedesmus bijugatus (Turp.) Kuetz.
Scenedesmus obliquus (Turp.) Kuetz.
Scenedesmus quadricauda (Turp.) Bréb.
Tetraedron minimum Reinsch
Tetraedron reticulatum (Reinsch) Hansg.
Tetraedron trigonum (Naeg.) Hansg.
Urococcus insignis Hass.
 Protococcaceae.
Characium ambiguum Hermann
Chlorococcum humicola (Naeg.) Rabenh.
Characium subulatum A. Br.
Gloeocystis gigas (Kuetz.) Lagerh.
Gloeocystis vesciculosa Naeg.
Ophiocytium capitatum Wolle

- Hydrodictyceae.
Coelastrum sphaericum Naeg.
Pediastrum angulosum (Ehrenb.) Menegh.
Pediastrum boryanum (Turp.) Menegh.
Pediastrum duplex clathratum A. Br.
Pediastrum tetras (Ehrenb.) Ralfs
- Ulotrichaceae
Microspora amoena (Kuetz.) Rabenh.
Microspora pachyderma (Wille) Lagerh.
Microspora stagnorum (Kuetz.) Lagerh.
Hormiscia subtilis variabilis (Kuetz.) Kirchn.
- Chaetophoraceae.
Chaetophora cornu-damae (Roth) Ag.
Chaetophora elegans (Roth) Ag.
Gongrosira debaryana Rabenhorst
Stigeoclonium aestivale (Hazen) Collins
Stigeoclonium glomeratum (Hazen) Collins
- Oedogoniaceae.
Bulbochaete Ag. sp.
- Oedogonium* Link (several species not in fruit.)
Oedogonium capilliforme australe Wittr.
Oedogonium cardiacum (Hass.) Kuetz.
Oedogonium crispum uruguayense Magn. and Wille
Oedogonium fragile Wittr.
Oedogonium grande Kuetz.
Oedogonium varians Wittr. and Lund.
Oedogonium vaucherii (LeCl.) A. Br.
- Coleochaetaceae.
Coleochaete orbicularis Pringsh.
- Cladophoraceae.
Cladophora glomerata (L.) Kuetz.
Rhizoclonium hieroglyphicum (Ag.) Kuetz.
- Vaucheriaceae.
Vaucheria D.C. sp.
- Characeae.
Chara Vaill. sp.
Chara contraria A. Br.
Chara evoluta Allen
Chara foetida rabenhorstii T. F. Allen
Chara fragilis Desv.
- Helminthocladiaceae.
Batrachospermum vagum Ag.

PUBLICATIONS CONSULTED

1. Agardh, J. G. Species, genera, et ordines algarum. 3 vols. 1848-1880.
2. Allen, T. F. Characeae Americanae, illustrated and described. Parts I and II. 1879.
3. ———. The Characeae of America, Parts I and II. 1880.
4. ———. Characeae. N. Y. State Museum Nat. Hist. 38th ann. report. 16, 15 Jan. 1885.
5. ———. The Characeae of America. Parts I and II, Fasc. 1, 2, and 3. 1888-1896.
6. Bessey, Charles E. Supplementary list of recently reported species. Webber's appendix to the catalogue of the flora of Nebraska, second edition. Contributions from the Bot. Dept. of the Uni. of Nebr. New series III:45-53, 1892.
7. Bessey, Charles E. and Webber, H. J. Report of the botanist on the grasses and forage plants and the catalogue of plants. Extracted from the report of the Nebraska State Board of Agriculture. 1889-1890.
8. Botanical Survey of Nebraska, conducted by the Botanical Seminar, II, 1892, and III. 1893.

9. Survey of Nebraska, conducted by the Botanical Seminar IV. Report on collections made in 1894-1895. 1896.
10. ———. Report on recent collections, Bot. Survey of Nebraska, pub. by Bot. Sem. 1901.
11. Birge, E. A. Absorption of the sun's energy by lakes. *Science*, 38:702. 1913.
12. Brannon, M. A. Factors influencing the flora of Devil's Lake, North Dakota. *Int. Rev. d. ges. Hydr. u. Hydro.* 4:291. 1911.
13. Brown, H. E. Algal periodicity in ponds and streams. *Bull. Tor. Bot. Club*, 35:223-248. 1908.
14. Brown, Wm. H. The plant life of Ellis, Great, Little, and Long's Lakes in North Carolina. *Contr. from the U. S. Nat. Herb.* 13:323-341. 1911.
15. Chambers, C. O. The relation of algae to dissolved oxygen and carbon-dioxide, with special reference to carbonates. 23rd ann. report Mo. Bot. Garden, pp. 171-207. 1912.
16. Collins, F. S. Green algae of North America. *Tufts College Studies*, vol. II, No. 3, pp. 79-480. 18 pls. 1909.
17. Comère, Joseph. De l'action du milieu consédérée dans ses rapports avec la distribution générale des algues d'eau douce. *Mem.* 25, *Bull. Soc. Bot. France*, 16:1-96. 1913.
18. Cook, M. C. *British Desmids.* 1887.
19. ———. British fresh-water algae exclusive of the Desmidiaceae and Diatomaceae. 2 vols. 1882-1884.
20. Copeland, W. F. Periodicity in Spirogyra. *Bot. Gaz.* 47:9-25. 1909.
21. Danforth, C. H. Periodicity in Spirogyra with special reference to the work of Benecke. *Ann. Rep. Mo. Bot. Garden*, 21:49-59. 1910.
22. Dangeard, P. A. Determination of the rays concerned in chlorophyll synthesis. *Bul. Soc. Bot. France* 60:166-175. 1914.
23. DeToni, J. Bapt. *Sylloge algarum* I, 1889, V, 1907, IV, 1897-1905.
24. Engler, A. und Prantl, K. *Die natürlichen Pflanzenfamilien*, Teil I. 1897-1900.
25. Fritsch, F. E. and Rich, Florence. Studies on the occurrence and reproduction of British fresh-water algae in nature. *Ann. Bot.* 21:423-436. 1907.
26. Gomont, M. Maurice. *Monographie des Oscillariees.* (Nostocacees Homocystees). 1893.
27. Halstedt, P. D. Classification and description of the American species of Characeae. *Proc. Boston Soc. Nat. Hist.* XX. 1879.
28. Hassall, Arthur Hill. *A history of British fresh-water algae.* 1845.
29. Hirn, K. *Monographie und Iconographie der Oedogoniaceen.* *Acta Soc. Sci. Fennicae* 27. 1900.
30. Kützing, F. T. *Phycologia generalis oder Anatomie, Physiologie, und Systemkunde der Tange.* 1843.
31. Migula, W. *Kryptogamen-Flora von Deutschland, Deutsch-Österreich, und der Schweiz im Anschluss an Thome's Flora von Deutschland.* Band II: 1 Teil, 1907, und 2 Teil, 1909.
32. Murray, Sir John and Hjort, Dr. Johan. *The depths of the ocean.* 1912.
33. Needham, James G. and Lloyd, J. T. *The life of inland waters.* 1916.

34. Oltmanns, Dr. Friedrich. *Morphologie und Biologie der Algen*. 2 vols. 1905.
35. Petit, Paul. *Spirogyra des environs de Paris avec XII planches*. 1880.
36. Pool, R. J. A study of the vegetation of the sandhills of Nebraska. *Minnesota Botanical Studies*, Vol. 4, Part III. 1914.
37. Rabenhorst, Ludovico. *Flora europaea algarum aquae dulcis et submarinae*. 1864-1868.
38. Robbins, W. W. A preliminary list of the algae of Colorado. *Univ. of Colo. Studies*, 9:105. 1912.
39. Robinson, Ch. Budd. The Chareae of North America. *Bull. N. Y. Bot. Garden* 4: 244. 1906.
40. Saunders, D. and Woods, A. F. *Flora of Nebraska*, published by the Bot. Sem. Parts I and II. 1894.
41. Schmidle, W. Einige Algen aus Denver, Colorado, U. S. *Hedwigia* 34:84-85. Figs. 1, 2, 3a, and 3b. 1895.
42. Smith, J. G. and Pound, R. *Flora of the sandhill region of Sheridan and Cherry counties and lists of plants collected on a journey through the sandhills in July and August, 1892*. *Bot. Sur. Nebr. II*. 1893.
43. Tilden, Josephine E. The Myxophyceae of North America and adjacent regions including Central America, Greenland, Bermuda, the West Indies, and Hawaii. *Minnesota Algae I*. 1910.
44. Transeau, Edgar N. The periodicity of algae in Illinois. *Trans. Am. Mic. Soc.* 32:31. 1913.
45. Webber, H. J. Fresh-water algae of the plains. *Am. Nat.* 23:1011-1013. 1889.
46. ———. A second edition of Webber's appendix to the catalogue of the Flora of Nebraska. *Contributions from the Bot. Dept. of the Univ. of Nebr. New series III:1-44*. 1892.
47. ———. Appendix to the catalogue of the Flora of Nebraska. *Contribution from the Shaw School of Botany. No. 9. Trans. Acad. of Sc. St. Louis*, 6:1-47. 1892.
48. West, G. S. A treatise on British fresh-water algae. 1904.
49. ———. The algae of the Yan Yean reservoir, Victoria; a biological and ecological study. *Jour. Linn. Soc.* 39:1-80. 1909.
50. ———. *Algae*. Vol. I. 1916.
51. West, W. and West, G. S. A monograph of the British Desmidiaceae. 4 vols. 1904-1912.
52. ———. On the periodicity of the Phytoplankton of some British lakes. *Jour. Linn. Soc.* 40:395-432. 1912.
53. Whipple, G. C. and Parker, H. N. On the amount of oxygen and carbonic acid in natural waters and the effect of these gases upon the occurrence of microscopic organisms. *Trans. Am. Mic. Soc.* 23:103-144. 1902.
54. Wolle, Rev. Francis. *Desmids of the United States and list of American Pediatrumstrums with 1,100 illustrations*. 1884.
55. ———. *Fresh-water algae of the United States, (exclusive of the Diatomaceae) complimentary to desmids of the U. S., with 2,300 illustrations*. 1887.

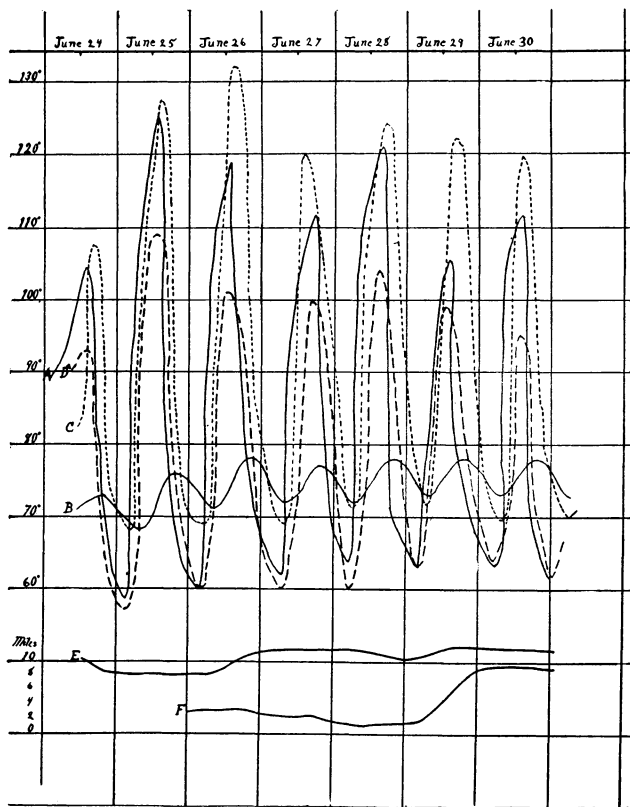
EXPLANATION OF FIGURES

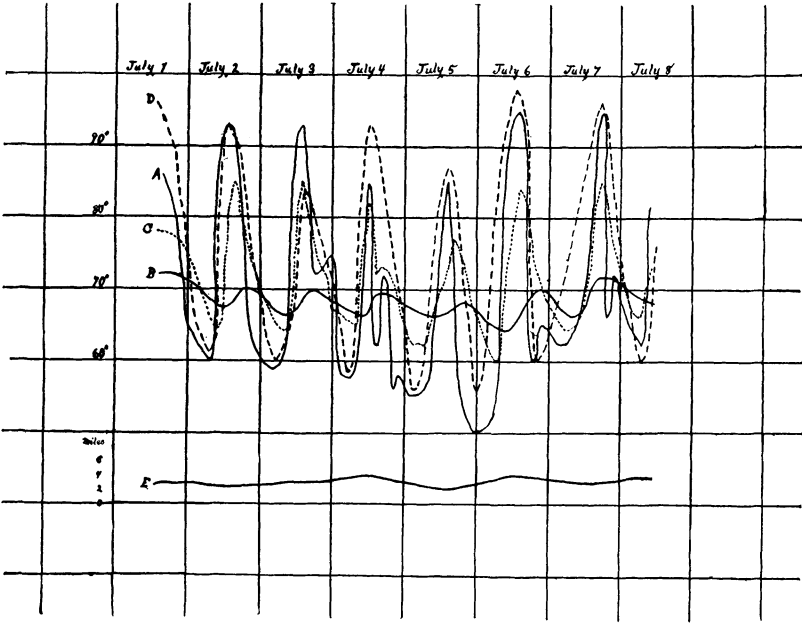
- Fig. 1. Map showing the lake region in Cherry County, Nebraska. Clear white areas represent water, dotted areas wet meadows, and ||||| swamps. (From map by Dr. G. E. Condra).
- Fig. 2. A view taken from the top of a sandhill and showing at the front left a part of Clear lake, at the upper left a part of Dewey lake and in the distance at the right a narrow strip of White Water lake, also the "sandhills" and the meadows surrounding the lakes. (Photo by F. H. Shoemaker).
- Fig. 3. Hackberry lake from the northeast shore.
- Fig. 4. Taking water photometer records among the rushes on Hackberry lake.
- Fig. 5. Submerged moss stems covered with *Nostoc glomeratum*—Hackberry lake. (Photographed under water).
- Fig. 6. Section of *Scirpus* stem covered with *Chaetophora cornu-damae* and *Nostoc glomeratum*. (Photographed under water).
- Fig. 7. Water photometer records on solio paper. Upper row exposures made in air. Three lower lows exposures made under water.
- Fig. 8. Thermographs and anemometers in a blowout near the shore of Hackberry lake.
- Fig. 9. Thermographs and anemometers in the grassy meadow on the shore of Hackberry lake.
- Fig. 10. Lower end of water photometer showing water tight drum and window covered with ray filter. (Photo by F. H. Shoemaker.)
- Fig. 11. Upper end of water photometer showing lever by means of which successive areas of the photographic plate may be exposed to the window. (Photo by F. H. Shoemaker.)
- Fig. 12. Above, under side of upper half of drum showing perforated, revolving disk to which photographic plates are attached by means of two clips. (Photo by F. H. Shoemaker.)
- Fig. 12. Below, upper half of water tight drum with lower half and tube removed. (Photo by F. H. Shoemaker.)
- Fig. 13. Clear lake from a sandhill at its southwest end. At the right in the distance a narrow strip of Willow lake. (X) the location of springs shown in fig. 14.
- Fig. 14. Pockets of spring water on the southwest shore of Clear lake.
- Fig. 15. Chart showing: A, temperature of air; B, temperature of soil 8 inches below surface; and C, temperature of surface soil at a station in a blowout near the shore of Hackberry lake. Also D, temperature of air in shade of a building on the lake shore; E, wind velocity at the rim of the blowout; and F, wind velocity at the bottom of the same blowout. Numbers at the left indicate, above temperature in Fahrenheit and below miles per hour of wind velocity.
- Fig. 16. Chart showing: A, temperature of air; B, temperature of soil eight inches below the surface; and C, temperature of surface soil at a station in the grass near the lake shore; also D, temperature of air in the shade of a building on the lake shore; and E, wind velocity for the same period. Numbers at left indicate, above temperature in Fahrenheit and below miles per hour of wind velocity at the station.

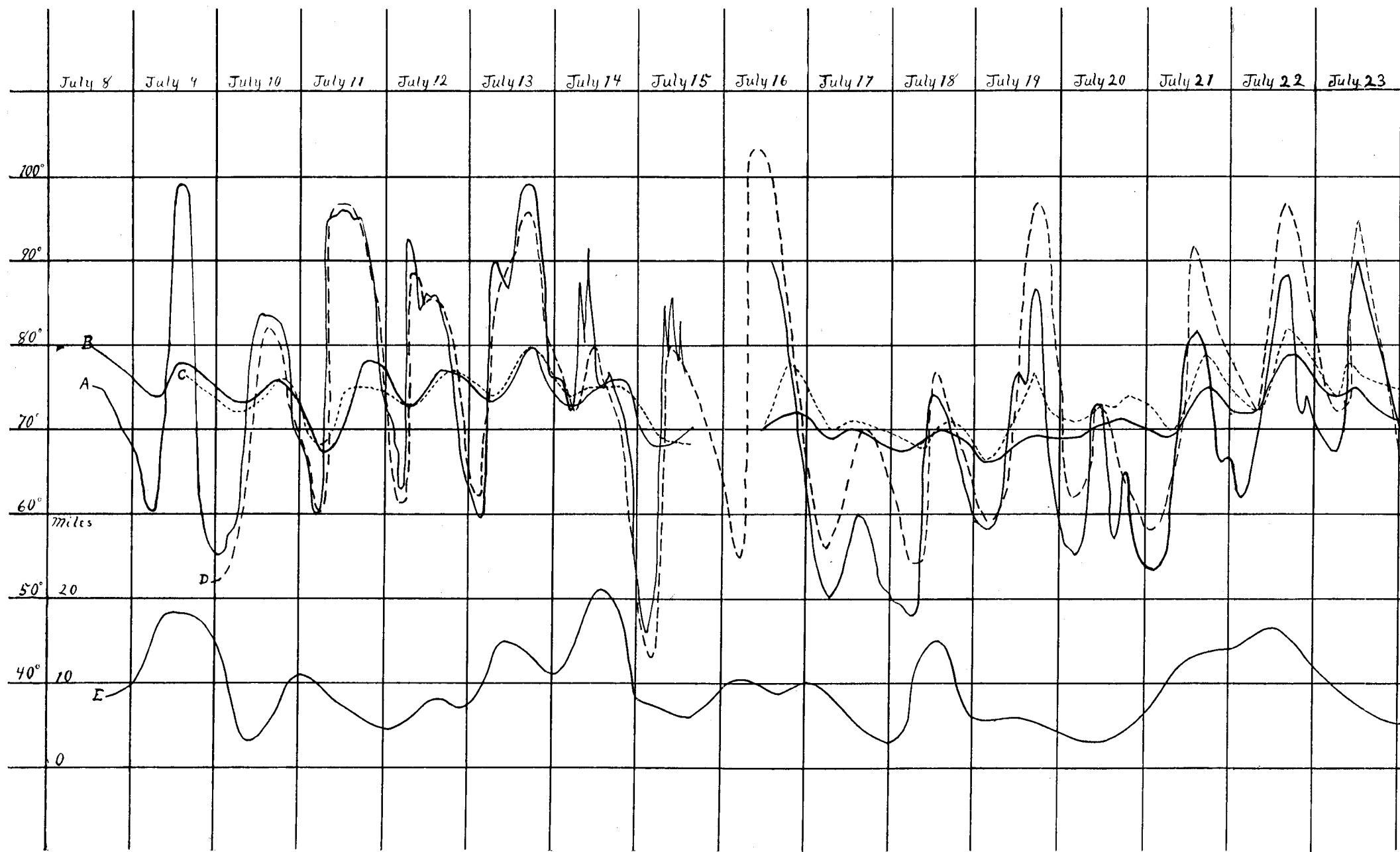
Fig. 17. Chart showing: A, air temperature; B, temperature of water at the bottom of lake (3 feet below surface the first week, $4\frac{1}{2}$ feet below surface the second and third week, and 5 feet below surface the fourth week); C, temperature of water at surface of lake at a station located in a boat anchored in the lake; D, temperature of air in shade of a building on the lake shore; E, wind velocity at margin of lake. Numbers at left indicate above temperature in Fahrenheit and below miles per hour of wind velocity. July 24-27 anemometer readings were not taken. It was a period of very low wind and is indicated approximately by the dotted line.

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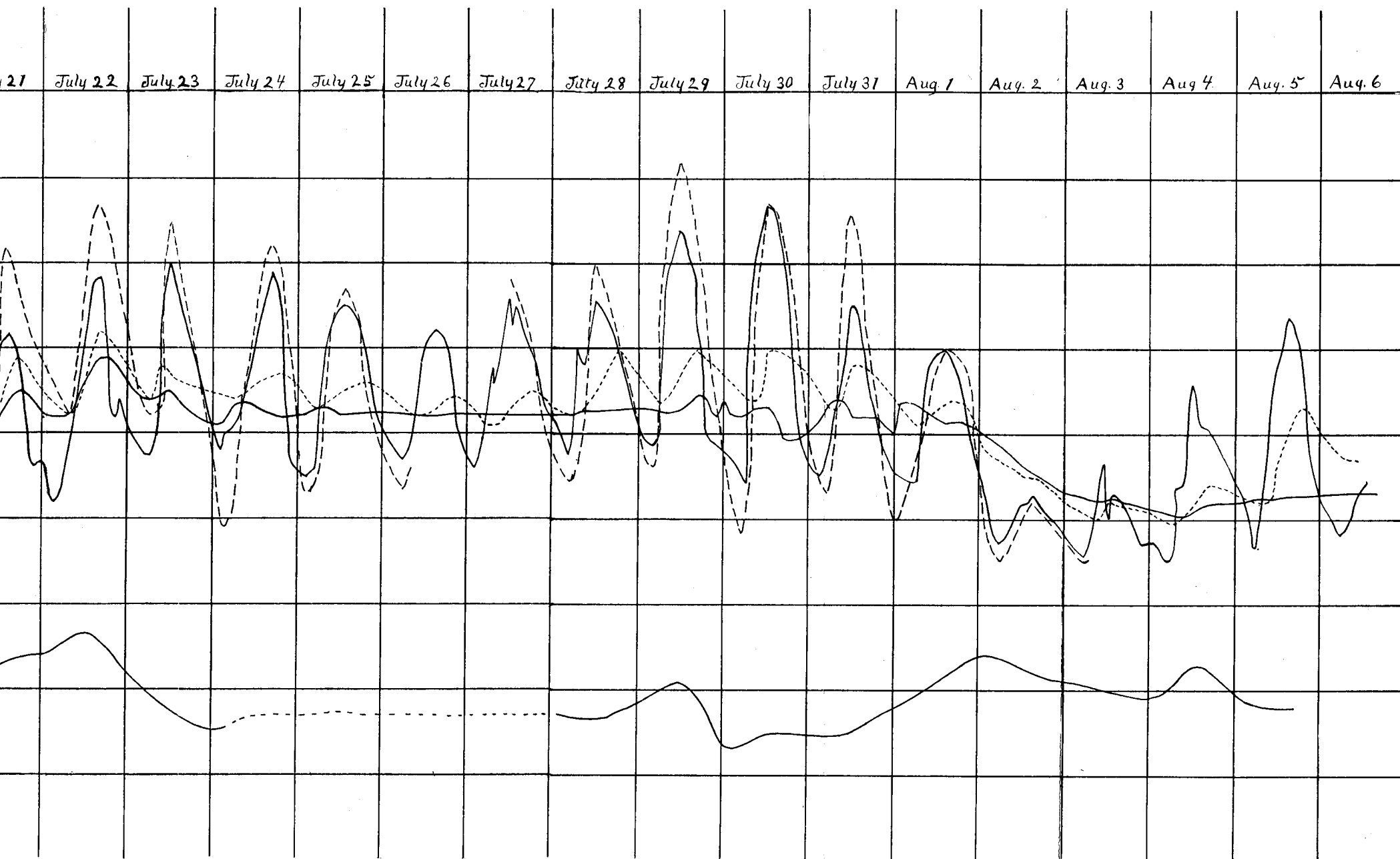


Fig. 17.

ANDERSEN AND WALKER